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CALIFORNIA FOREST AND RANGE EXPERIMENT STATION

FOREST SERVICE - U. S. DEPARTMENT OF AGRICULTURE

CONTENTS

Cover: Snow management researcher checks instruments used to measure wind speed and direction during snow storms at Central Sierra Snow Laboratory.

THE CHALLENGE OF INTENSIVE MANAGEMENT

One trend stands out in the 1957 picture of California forestry--a move toward more intensive management. Despite a soft market, lumber production continued high. A growing plywood and veneer industry used more logs, and a developing pulp industry became established on the Sacramento River. Range managers, striving to boost livestock production, could see in mounting recreational use of wild land a need to increase forage crops and shelter for wildlife. Every daily newspaper, the State Water Plan, the work of legislative committees and civic study groups, reminded forest and range managers that water is one of their main products. Where did research fit in this picture?

For one thing, it emphasized that a high order of protection is the keystone of intensive management. The station's forest pest surveys, now set up to do a good job of detection and appraisal in cooperation with public and private foresters, showed that without effective protection rapid strides toward maximum production will be impossible.

Timber losses caused by bark beetle attacks increased nearly everywhere in the State. They were held to acceptable levels only in timber stands harvested according to methods developed by research to keep beetle-caused damage low. Dwarfmistletoe, a deceptively inconspicuous parasite, is now recognized as a major pest and a serious threat to the young stands that will provide tomorrow's timber. To help foresters combat dwarfmistletoe, we have summarized in Technical Paper 19 what we know about their growth habits and control.

Forest fire control agencies, considering the weather, had a good record this year. One reason was the success of air attack and chemical fire retardants developed in the past 2 years. We are continuing this work, and have strengthened forest fire research in the fields of prevention and initial attack.

The emphasis in protection studies and in other station activities varies from section to section of the State. This too, is a reflection of the move toward intensive management. Generalized knowledge is becoming less helpful as land managers try to apply it acre by acre, and such specific information as the cooperative soil-vegetation survey provides is becoming more valuable.

IN NORTHWESTERN CALIFORNIA the spectacular growth of Douglas-fir logging is stimulating greater interest in future timber crops. Livestock ranchers have asked for information on the relative merits of timber production and grazing on cutover land, and their requests led to an economic study completed this year in cooperation with the Agricultural Research Service. Also indicative is the success of a guide to forest planting we published for this area--the first edition was nearly exhausted in 2 months. National-forest resource managers are cooperating in studies of forest regeneration problems, and we have started studies of cone and seed insects that are responsible for some lean seed crops.

Range management studies have turned to pilot-plant application of past findings on brushland conversion. On the Mendocino National Forest this work is showing that land managers can replace chamise brush with forage plants and at the same time help reduce fire hazards.

Forward-looking loggers are adopting practices that help protect streamflow and water quality. These practices will receive special attention at Yurok Redwood Experimental Forest, where, with the Simpson Redwood Co., we have completed a cutting plan for a 5-year cooperative study of redwood management. As yet, however, the problems of improving streamflow for water supply and recreational uses have not been attacked on an appropriate research scale.

EAST OF THE SIERRA NEVADA, speedy adoption of the Harvey Valley grazing system for bunchgrass ranges shows that range and livestock managers are alert to innovations. Though the pilot test of this system is only 6 year old, it is far along its objective of doubling the grazing capacity of deteriorated ranges in 20 years; already several national forests are adopting this system.

Wildlife has long been recognized as one of the major wild land products in northeast California. In recent years hunters and anglers have brought increasing income to the area. The prime deterrent to better hunting is the poor condition of the habitat. Our game-browse project, conducted in cooperation with the California Department of Fish and Game, showed this year that bitterbrush, a key browse species, can be reseeded.

Forest managers in this area have applied cutting methods developed to reduce bark beetle damage--and it was here that timber losses were generally lower than the statewide losses. To help step up growth of young stands, studies at Blacks Mountain Experimental Forest are being analyzed in order to suggest the most effective organization of thinning crews. Cutting experiments in red fir at Swain Mountain Experimental Forest, however, were delayed by failure of the timber sale; a reappraisal should get this work started in 1958.

New research in the eastside is oriented mainly toward intensive management. It includes coordination of snow management with timber management at Swain Mountain, streamflow studies in cooperation with University of California at Sagehen Creek in the Truckee River drainage, and evaluation of lightning-prevention studies headed by the California Division of Forestry.

ON THE WEST SIDE OF THE SIERRA, snowpack studies in cooperation with the State Department of Water Resources are developing methods of management for maximum water yield. These studies now include four major watersheds of the Sacramento and San Joaquin Rivers, where we are tracing the behavior of snow in the forest and water in the soil and streams. First summarizations indicate that improved water yield may require management of brush in openings as well as timber management.

The possibility of increasing timber production by planting genetically improved trees has been demonstrated by hybrids from the Institute of Forest Genetics at Placerville. Test stock planted on national forests and other land is doing well. Though it will take time to check performance of the hybrids to maturity, demand for planting stock runs high. Their production in economic quantity is urgently needed. Foresters

are also looking to young-growth pine and to hardwoods for new timber products in this area. To help answer their questions on management of these types, we opened Challenge Experimental Forest near Oroville and drew up plans for cooperative cutting experiments.

Range fertilization and conversion of brushland to grass are becoming more widespread in the foothills. A series of manuscripts recently submitted for publication tells how sulfur fertilization benefitted herbage and livestock production in studies at the San Joaquin Experimental Range. There, an enlarged staff is looking forward to a grazing management study which will mean as much for the annual grass type as the work at Harvey Valley has for bunchgrass. We have started wind movement studies around prescribed burns in cooperation with the California Division of Forestry; from this work we hope to develop methods for forecasting burning conditions that will aid brushland clearing as well as fire-fighting forces.

IN SOUTHERN CALIFORNIA, too, more intensive management of wild lands is on the march. Land managers and research workers have started tests on entire watersheds aimed at obtaining more good water. At San Dimas Experimental Forest, the stream bottom of Monroe Canyon is being cleared as part of a prescription based on 25 years of forest-influences studies. Preliminary studies of defoliating chaparral with chemicals suggest that management of vegetation in place may be helpful in saving water.

Fire research is emphasizing study of pre-fire planning with the start of a large cooperative project called Fuel-Break. The objective of this work is to refine or develop methods for breaking up large expanses of brush and making it easier to keep small fires from becoming disastrous. This work will soon move into a pilot-plant scale. With California Division of Forestry cooperation, prevention research has been increased. We are also beginning studies in the psychology of law enforcement and an operations research program seeking more effective use of new fire-fighting tools in initial attack.

Forest insect and disease outbreaks are especially critical in southern California high value recreation areas.

Several short-time studies have shown that special cutting methods can be adapted to cut down damage by bark beetles, but much more must be done if these timbered areas are to be saved for recreation.

OUTSIDE CALIFORNIA, the Station was given responsibility for the first survey of forest resources in Hawaii. There trees planted for watershed purposes during the past 30 years have shown tremendous growth and yield potentials. The Territorial Board of Commissioners of Agriculture and Forestry have recognized that greater production from watershed, range, and timber land can help bolster Island economy. They have provided funds to conduct a survey and have asked the Forest Service for assistance. A specialist from the Station was transferred to the Islands in November to head up the Hawaiian forest survey and assist the Territorial forester with cooperative forestry programs.

Intensive management is the trend everywhere--land managers and research workers will both need to stay alert to new problems.

FOREST ECONOMICS RESEARCH

FOREST SURVEY EXTENDED TO HAWAIIAN ISLANDS

The Hawaiian Islands include a land area of more than 4 million acres; about 2 million is productive or potentially productive forest land. The timber on this land could contribute substantially to the Territorial economy: the demand for wood is growing, and local production would provide jobs to help support the Island population.

But little information is available to guide industrial development. Forest land suitable for commercial use has been only roughly mapped. The condition of timberlands and the volume, quality, and growth rates of timber stands have not been inventoried. Suitability of many species for local and export markets is not known.

This year the Station took the first steps toward providing such information. In cooperation with local officials, a branch office was established in Honolulu and a project leader transferred there in November. His primary responsibility will be to conduct a forest survey of the Islands. The project leader will also represent the Forest Service in assisting the Territorial Forester with cooperative public and private forestry programs--including forest nursery and fire-control work--already established there.

Much of the brush-covered land in the Hawaiian Islands could support commercial forest plantations, like this one of Eucalyptus on Maui.

SECOND FOREST SURVEY STARTED FOR CALIFORNIA

The second Forest Survey of California's timber resources was started in 1957 with development of a working plan and remeasurement of a sample of survey plots. The first, started in 1946, was completed in 1954 with publication of the report "Forest Statistics for California." These projects are part of a national program of the Forest Service to obtain current information on the forests of the United States. Repeated inventories are essential to show changes in the area, volume, condition, and growth of forests, the volume cut, and losses from fire, insects, disease, and other causes.

The plan calls for full use of aerial-photo techniques for estimating the area of forest land by kind of land use, forest type, and size of timber. To get volume data on these areas, survey crews will remeasure part of the initial survey plots and a sample of new plots. Estimates of growth and mortality losses will be obtained from remeasured plots; of timber cut from remeasured plots and special surveys of timber product output; and of total volume from both remeasured plots and new plots by means of a statistical technique using double-sampling and regression analysis.

A more economical survey should result from this technique because it reduces the number of field plots that need to be measured. Survey crews remeasure only a small part of the initial sample plots. Their present volume is compared with their volume at the first survey. The higher the correlation between the present and previous volumes, then the fewer plots must be remeasured to estimate the total present volume to a specified standard of accuracy. Analysis of plots measured to date shows a high order of correlation, with a correlation coefficient of +0.86.

LOCAL CHARCOAL SUPPLIES SMALL PART OF MARKET

As part of a nationwide survey of charcoal production carried on by the Forest Service, a canvass was made of all known California producers. In 1956, 39 operators produced about 4,650 tons of wood charcoal--up 48 percent from the 3,150 tons produced by 28 operators in 1955. About 9,180 cords of round wood--99 percent oak--were required in 1956 to run about 134 kilns with a total capacity of 1,390 cords per coaling cycle. Since the cycle averaged about 15 days, most kilns were not used to capacity.

California's wood charcoal production is only about one-tenth of its consumption. Another tenth may come from charring of fruit pits and nut shells, and nearly a tenth is imported--largely from Mexico. But the major part, about seven-tenths, comes from the eastern United States.

CALIFORNIA TIMBER INDUSTRY SHOWS CONTINUED GROWTH

One of our major jobs was a survey of timber products output in California during the calendar year of 1956, conducted in cooperation with the Bureau of Census. The results underlined again the continued growth of California's timber economy.

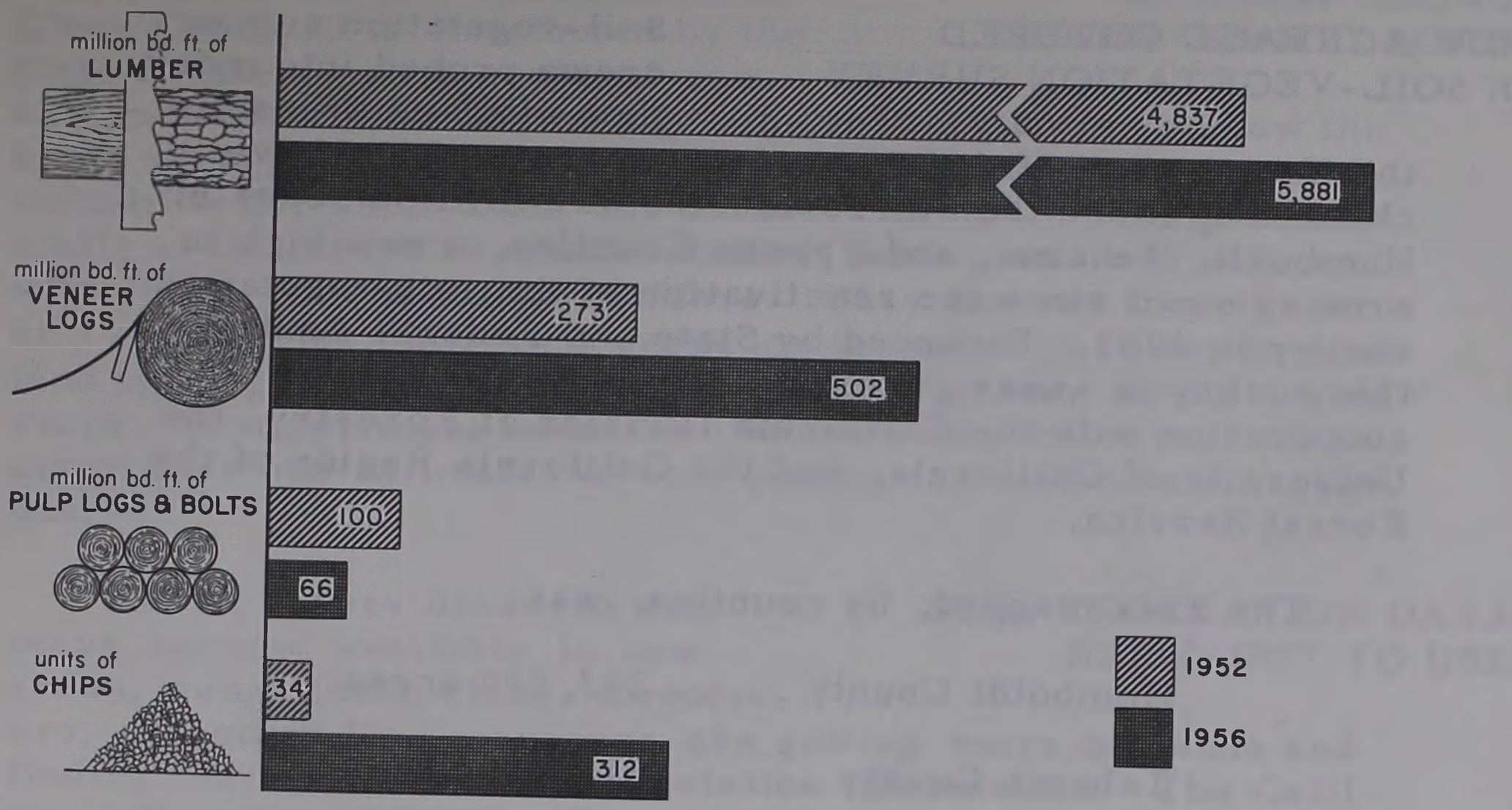
We asked sawmills to let us know how much lumber of each species they sawed. To complete the picture, we also asked producers for the volume of each speices cut for saw-logs, veneer logs, pulp logs, poles, piling, mine timbers, shingle bolts, and split products (like posts, stakes, paling, and shakes). We received replies from most of the pro-ducers, largely by mail but some through field contacts, and estimated the output of those not replying.

Major segments of the industry reported increased pro-duction. Though the sawmills were already feeling the pinch of a soft lumber market, the cut of sawlogs reach a new high. So did the output of veneer logs. The cut of pulp logs and bolts was down, but wood chips from sawmill and veneer residues more than made up the difference--they supplied more than half the raw material for fiber and particle board uses.

Pole production probably reached a new high, split products increased a bit, but other products were down.

The production figures were:

Lumber	5,881 million board-feet
Veneer logs	502 million board-feet
Pulp logs & bolts	66 million board-feet
Poles	179 thousand pieces
Piling	1,086 thousand lineal feet
Mine timbers	149 thousand cubic feet
Shingles & sawn shakes	36 thousand squares
Split products	1,700 cubic feet



TIMBER QUALITY RESEARCH CONTINUING

The Station had several opportunities to further its work on timber quality problems. Several staff members attended a nationwide conference on timber quality, held at the Forest Products Laboratory at Madison, Wisconsin. One important outcome of this conference was the establishment of a national log-grade working group, reporting directly to Washington. A member of the Station staff was selected as leader of this group. Much of his time was devoted to a nation-wide analysis of log and tree grading problems. The findings of his group will steer a coordinated program of Forest Service research in this important field.

Lumber recovery data were collected from a mill-scale study of white fir logs and used to ev luate various external indicators of log quality. We are trying by this analysis to separate different logs into distinct "value classes." When the study is completed next year, we hope it will provide guides for further testing and development of log grades.

NEW ACREAGE COVERED IN SOIL-VEGETATION SURVEY

Soil-vegetation survey crews probed into many new wildland areas in this fourth year of the cooperative survey. They have chalked up more than three-fourths of a million acres in Humboldt, Tehama, and Fresno Counties, a new high in area covered since the reactivation of the soil-vegetation survey in 1953. Financed by State and Federal funds, this survey is under general direction of the Station in cooperation with the California Division of Forestry, the University of California, and the California Region of the Forest Service.

The area mapped, by counties, was:

Humboldt County ..... 293,000 acres

Tehama County ..... 316,000 acres

Fresno County ..... 180,000 acres

Mapping is also underway in the Big Creek watershed of the Sierra National Forest for a special Forest Service pilot study. The California region wants to find how basic information about soils and vegetation can be best used to tackle problems in land management. Because the study area, about 50,000 acres, has a variety of soils, vegetation, and topography, it offers a challenge for land-use planning. The project is one of several being set up on national-forests throughout the United States.

Map publication increased substantially. Quadrangle sheets at 2 inches to the mile were published for more than 600,000 acres in Fresno, Glenn, Humboldt, and Tehama Counties. Maps for Glenn County are now complete. Two kinds of maps are published for each quadrangle: a Timber Stand-Vegetation Cover map and a Soil-Vegetation map. The first shows the age and density of timber stands, density of woody vegetation, and broad types of vegetation and other elements. The second shows the soil series and phases, species composition of vegetation, site quality of timber croplands, and grassland sampling locations.

NEW MAP SHOWS GLENN COUNTY SOILS

The new map, "Upland Soils of Glenn County," is distributed by the State Printer. At a scale of one-half inch to a mile, this map groups soils by color to show the kinds of vegetation they normally support and their general suitability for use. Land-use planners can pick out soils normally associated with conifer timber, with grass and oak, and with chaparral and minor conifers. They can see those generally suitable for cultivated crops or intensive pasture, or find land types generally unsuited for timber, grass, or cultivated crops. A supplement tabulates the more important soil characteristics and estimates of soil quality for timber and range use.

SOIL-VEGETATION DATA BEING PUT TO USE

As the survey broadens and maps become available in new areas, range technicians, foresters, and other land managers are getting more demands and finding more uses for soil-vegetation information. The California Division of Forestry conducted a 4-day training session in Mendocino and Humboldt Counties for its technicians. The training emphasized application of soil-vegetation data in solving land-use problems in those counties. Another training session, sponsored by the Division of Forestry and the Agricultural Extension Service in Tehama County, was held for about 40 foresters, range managers, and farm advisors representing public agencies and private industry. Reports from the Weyerhaeuser Timber Company in Oregon indicate they are making good use of soil-vegetation survey data in their intensive management programs.

Research workers at the Station also are finding the basic data on soils and vegetation helpful in planning experimental work. Special research surveys were made for this purpose in 1957 at the Yurok-Redwood and the San Dimas Experimental Forests. An example of this kind of survey is reported in a new Station publication: Soil-Vegetation Survey of the Central Sierra Snow Laboratory Basin.

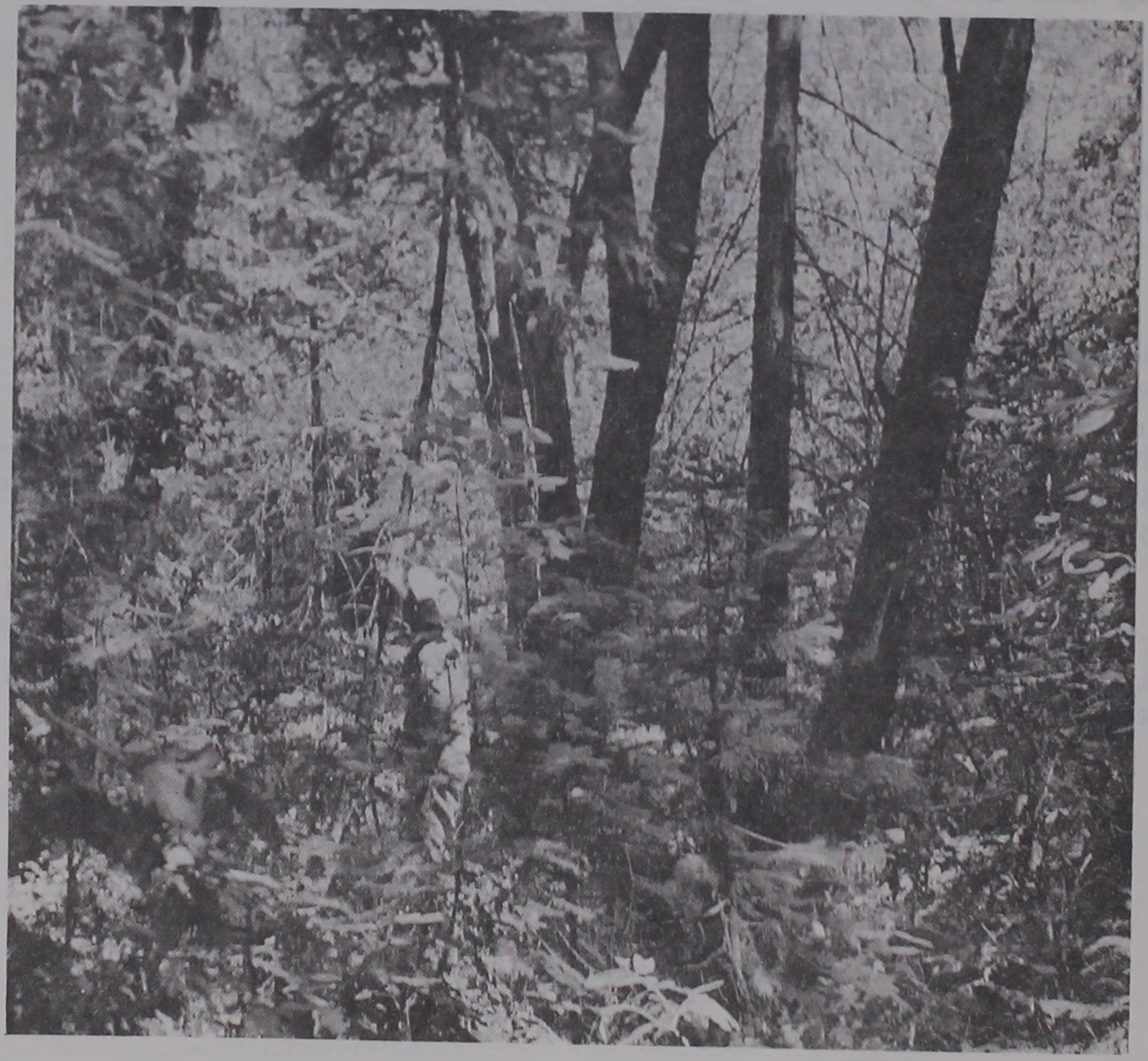
Evidently our soil-vegetation work is gaining international recognition. This summer, visiting professors from Argentina and Formosa spent some time with our field personnel learning about survey techniques.

FOREST MANAGEMENT RESEARCH

RESEARCH PROGRAM STARTED IN YOUNG-GROWTH FORESTS

In the trend toward more intensive forest management, the demand for knowledge about young-growth timber is becoming more urgent as the remaining old-growth decreases. To help develop this knowledge, we assigned a research forester to plan forest management studies at the Challenge Experimental Forest. The timber at Challenge is representative of the mixed-conifer young-growth which covers a million acres along the western slopes of the Sierra Nevada at elevations of 2,000 to 4,000 feet. Already we can see that managing these young-growth stands efficiently will require immediate attention to some pressing problems.

Hardwoods and shrubs in this timber stand at Challenge Experimental Forest compete with young conifers.



For instance, what are the most suitable ages for harvesting young-growth? For the most favorable balance between investments and returns, timber should be cut neither too soon nor to late. Volume growth increases up to a certain age and then starts to decline; quality of the timber may continue to improve for considerably longer.

Or take intermediate harvest cutting--foresters generally believe that the greatest returns will be realized from a series of harvests, rather than from a single cutting. How can we choose for intermediate harvest the poorest trees and the trees that are going to decline in value? How can we pick the best trees for future cuts? The problem is to develop schedules for particular situations.

And what is the most economical, positive method to combat undesirable hardwoods and brush? Much of the young timber has an understory of broadleaf trees and shrubs. They compete with the most desirable species for soil moisture; they greatly hinder regeneration. If not suppressed, they are a serious hindrance to continuous production of timber.

These are but a few of the problems for which answers are urgently needed in forest management. We are also faced with problems related to watershed management, grazing, and recreation. Many of the findings at the Challenge Experimental Forest should also be applicable to the treatment of other young-growth mixed-conifer stands.

PRE-COMMERCIAL THINNING STUDIED IN PONDEROSA PINE

The tendency for dense seedling and sapling stands of ponderosa pine to stagnate or grow slowly on poor sites is well-known. Diameter and height growth of the young trees are negligible, and the condition may persist for many years. Relieving stagnation by means of pre-commercial thinning in young stands has been undertaken on the Blacks Mountain Experimental Forest in northeastern California.

The project began in 1955 and continued in 1957. Objectives were to work out practical techniques and obtain preliminary cost and production data. To date young stands totalling 44.8 acres have been thinned.

Lightweight power saws are used to speed thinning operations in northeastern California test.

The thinning was aimed at releasing 500 to 600 crop trees per acre, spaced 9 feet apart on the average. All except crop trees were cut. In mixed stands, white fir and incense-cedar were cut to release pine if the pine stocking was sufficient to warrant the work. Commercial "brushcutter" type circular and chain power saws were used in the thinning.

Cost and production data were analyzed in cooperation with the University of California School of Forestry. These were the findings:

Thinning required an average of one-fourth man-day per acre of management compartment; costs averaged $4.19 per acre and 10 cents per tree released. The stagnant young stands grew in patches so that the thinning crews did not cover every acre of the compartments. Consequently, production and costs varied a good deal. On one 88.6-acre compartment, for example, patches totalling only 5.9 acres were thinned. For this net acreage thinning cost $84.86 per acre and released 647 crop trees at a cost of 13 cents per tree. On a 75-acre compartment, 367 trees per acre were released on 14.2 acres at a cost of $33.07 per acre, or 9 cents per tree. These figures include the time required for: marking working areas on the ground, thinning, repairing and maintaining saws, and supervision. Transportation costs are excluded.

The significance of this work to forest managers is that it relates a method of thinning young stands to cost figures for the conditions encountered in the eastside pine type. In deciding whether thinning is economically justifiable on his property, the manager can compare the costs of thinning to the present worth of future yields from thinned, managed stands. Later research will provide estimates of the quantity and quality of yields so that the financial merits of pre-commercial thinning in seedling and sapling stands can be evaluated. For the time being, these production and cost figures can serve as a basis for deciding on alternative thinning methods or for a non-economic decision as to whether thinning should be done.

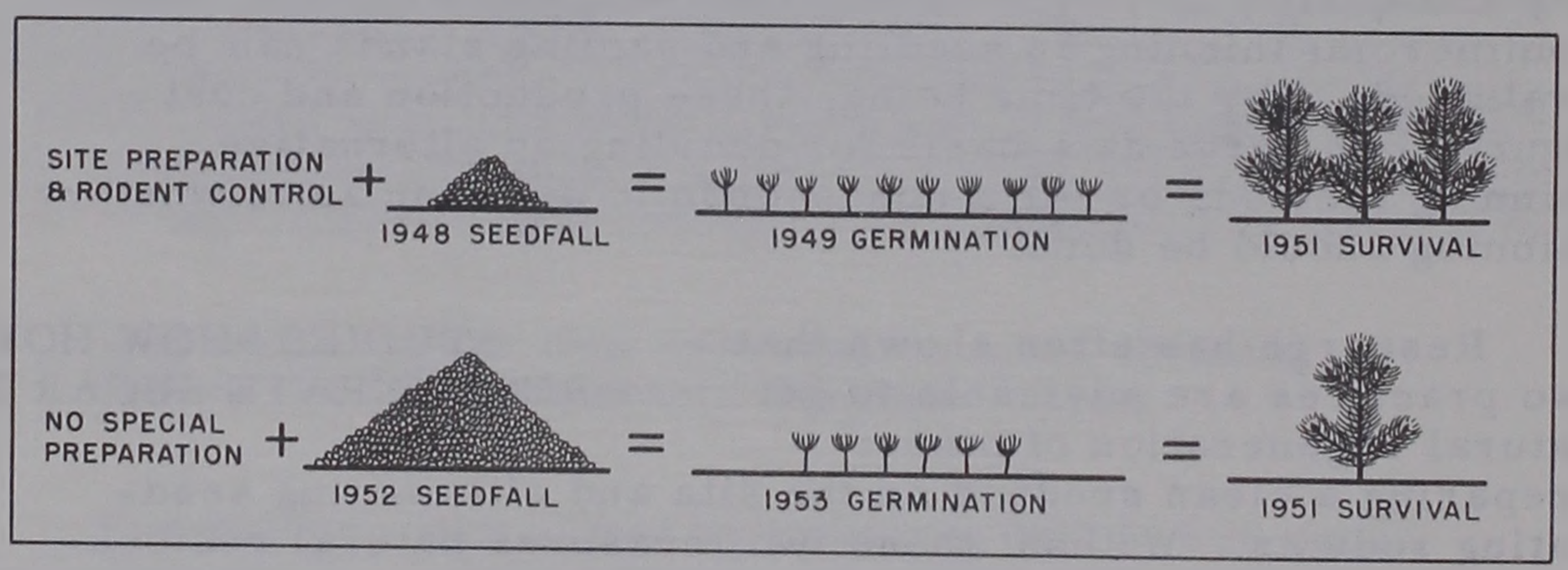
STUDIES SHOW HOW TO REGENERATE SUGAR PINE

Research has often shown that two practices are advisable to get natural regeneration of pines: preparing a clean seedbed on the site and eliminating seed-eating rodents. Without these two measures natural restocking of sugar pine after logging is questionable. A recent comparison of seedling establishment after a good seed crop in 1948 and an exceptionally heavy crop in 1952 on the Stanislaus Experimental Forest has reemphasized the value of these practices.

The study area was logged in 1948 before seedfall. Slash and all brush were bulldozed into piles and the area to be regenerated plus a buffer strip were treated with poison bait. Seedtraps paired with mil-acre quadrats were set out to measure seedfall and seedling establishment. In 1952--4 years after logging--the same seedtraps and quadrats were set out, but no further site preparation or rodent poisoning were done.

In the fall of 1948, sound sugar pine seeds fell into the seed-traps at the rate of 32,240 per acre. The next spring the adjacent quadrats were found to be stocked at the rate of 1,030 seedlings per acre. At the end of 3 growing seasons, the per acre stocking was 333. In other words, 31 sound seeds were required for every seed that germinated and 96 seeds were needed to produce one 3-year-old tree.

In comparison, 156,970 sound sugar pine seeds per acre were caught in the same seedtraps in the fall of 1952--about 5 times as many as in 1948. Next spring, germination counts indicated 606 seedlings per acre. Only 91 of these survived 3 growing seasons. Without site preparation and rodent control, the requirements were 259 seeds for every one that germinated and 1,727 seeds for every 3-year-old tree.



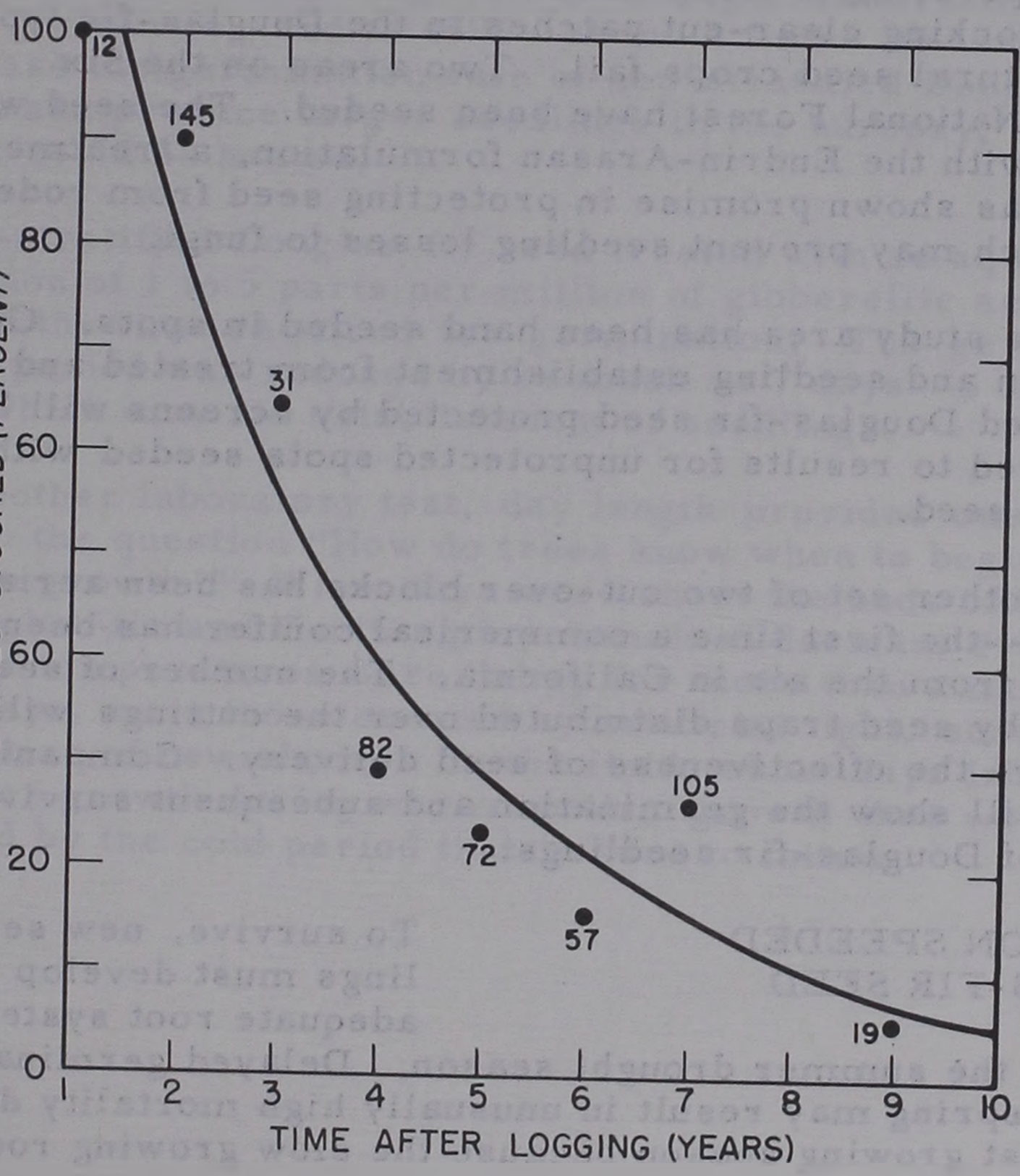
The better seedling establishment from the 1948 seed crop is even more striking since soil-moisture conditions favored the 1952 seed crop. More precipitation occurred in the late spring and early summer and the drought period was shorter in 1953 than in 1949.

These comparisons show that seed germinaton can be increased at least 8 fold and survival 20 fold by proper site preparation and rodent control. This means foresters need not wait for bumper seed crops to get adequate natural regeneration--providing they do in the field what research results have indicated needs to be done.

GET DOUGLAS-FIR STOCKING IN THREE YEARS--OR ELSE

A study of Douglas-fir reproduction from the bumper 1956 seed crop indicates that land managers should not wait too long for natural stocking on clear-cut blocks. If blocks do not restock naturally soon after logging, artificial regeneration probably will be necessary.

Clear-cut blocks ranging in age from freshly cut to 8 years old were examined for new seedlings. The number of Douglas-fir seedlings and the ground conditions were recorded for randomly selected samples of the cutover blocks.



We found the stocking by new seedlings intimately associated with the age of the cutover blocks. Stocking was good on cutovers 3 years old and younger but poor on older areas. Stocking is heavier on fresh cutovers because:

...More of the area is bare mineral soil--the best seedbed;
...There is less competing vegetation;
...And seed-eating rodent populations are lighter.

Results of the reproduction survey give a good lead--if you don't get natural Douglas-fir reproduction within 3 years after logging, get to work on artificial methods.

DOUGLAS-FIR CLEAR CUTTINGS SEEDED ARTIFICIALLY

The Experiment Station and National Forest Resource Management are cooperating to find a means less costly than planting for restocking clear-cut patches in the Douglas-fir type when natural seed crops fail. Two areas on the Six Rivers National Forest have been seeded. The seed was coated with the Endrin-Arasan formulation, a treatment which has shown promise in protecting seed from rodents and which may prevent seedling losses to fungi.

One study area has been hand seeded in spots. Germination and seedling establishment from treated and untreated Douglas-fir seed protected by screens will be compared to results for unprotected spots seeded with treated seed.

Another set of two cut-over blocks has been aerially seeded--the first time a commerical conifer has been seeded from the air in California. The number of seeds caught by seed traps distributed over the cuttings will measure the effectiveness of seed delivery. Companion plots will show the germination and subsequent survival rates of Douglas-fir seedlings.

GERMINATION SPEEDED IN DOUGLAS-FIR SEED

To survive, new seedlings must develop an adequate root system before the summer drought season. Delayed germination in the spring may result in unusually high mortality during the first growing season because the slow growing roots

are unable to maintain contact with the rapidly receding soil moisture. Consequently foresters often stratify seeds to speed germination. We have found, in cooperative studies at the California Institute of Technology, that germination of Douglas-fir seeds can also be speeded by light, heat, and gibberellic acid.

Non-stratified Douglas-fir seeds given long periods of light (16 to 24 hours per day) germinated at a much faster rate than seeds kept in the dark. Laboratory tests showed that the time required to get 50 percent germination was shortened by 10 to 23 days. Even relatively low light intensities of less than 1 percent direct sunlight were effective. The germination rate of stratified seeds was not affected by exposure to light.

At 75°F. germination rates were almost the same for stratified and non-stratified seeds. At 60°F. non-stratified seeds required twice as long (about 40 days) as stratified seeds to germinate, and at 45°F. about 4 times as long. To increase the germination rate of non-stratified Douglas-fir seeds and produce larger seedlings in the nursery, the seedbeds could be heated.

Non-stratified Douglas-fir seed treated with an aqueous solution of 1 to 5 parts per million of gibberellic acid shortened the time required for germination. The germination period was reduced by as much as 7 days--a difference which may aid establishment of seedlings.

In another laboratory test, day length provided one answer to the question "How do trees know when to begin vegetative growth?" When days were short the buds of bigcone Douglas-fir and Coulter pine remained dormant even though the temperatures were balmy for more than a month. Longer days, even those created by artificial light, soon led to production of new shoots. In the field, short days inhibit mid-winter growth during warm spells, growth that would be injured by the cold period that is sure to follow.

OLD-GROWTH REDWOOD EXPERIMENTS UNDERWAY

Which reproduction method--clear-cutting in patches, shelterwood, or selection--most effectively converts old-growth redwood into younger managed stands? Finding the answer to this question is the foremost objective of a cooperative research program with Simpson Redwood Company on the Yurok Redwood Experimental Forest in Del Norte County. The results from these studies are expected to furnish timely guides for managing the estimated 20- to 30-year supply of old-growth timber still remaining in the redwood region.

Some of the questions to be investigated are:

...How do different reproduction cutting methods and post-logging treatments affect natural regeneration of redwood?

...How does the growth of reserve trees in shelterwood cuttings compare to those left after selection cutting? And can the future growth of individual trees be predicted accurately?

...How do utilization problems differ for selection, shelterwood, and patch clear-cuttings?

...Can shelterwood and selection cutting areas be relogged without too much damage to reproduction and reserve trees?

...Can soil movement and streamside disturbance be be reduced to a minimum by careful road engineering and post-logging treatment of skid roads?

...Can the dangerous fire hazard of slash concentrations be eliminated without excessive damage to reserve trees?

Redwood region foresters and other interested persons will soon be able to see results on the ground when they visit the experimental forest. The first tract designed to test various methods of cutting has been located and the trees marked for cutting. The main access road is surveyed and staked for construction. Spur roads have been marked. Road building and logging will start when the timber appraisal is completed, and collection of post-logging data will begin by late summer of 1958.

Old-growth redwood on Yurok-Redwood Experimental Forest. Big tree on right contains more lumber than 5 average frame houses

FOREST GENETICS RESEARCH

COMMERCIAL PRODUCTION STARTS FOR HYBRID PINES

The objective of management is to obtain the maximum yield or profit from each acre of forest land. In silviculture as in agriculture, use of breeding products offers a powerful means of increasing yields. Many exceptional pine hybrids have been produced at the Institute of Forest Genetics, and field tests suggest that they offer commercial possibilities. Although none of these tests can be regarded as final or conclusive, management is nevertheless keenly interested in the possibilities, and the inclination to risk the hazards of their use is growing.

In this field test on the Eldorado National Forest, ponderosa pine and the hybrid between ponderosa and Apache pines are planted in alternate rows. At 3 years of age, hybrids are larger than the ponderosa checks.

This year, through cooperative arrangements, private and federal funds were invested in quantity production of hybrid seed. A California Christmas-tree grower and the Forest Service have undertaken such production. These probably are the first commercial ventures in producing pine hybrids in the West, if not in the United States.

One of the hybrids, a cross between coastal and inland varieties of lodgepole pine, promises to be an excellent Christmas tree. Its good growth characteristics will produce a well-shaped, bushy tree. Its stout branches will support decorations. Its short, stiff needles of a dark blue shade of green will give it crisp, pleasing color. Nature's own ornaments, persistent cones, decorate it as it is harvested. The hybrid is made by using pollen of the coastal variety on the inland, or mountain, variety. It should be well adapted to the climates of central and northern California. The full commercial value of the hybrid will, of course, be determined by its performance in the field and market.

Another hybrid, the cross between ponderosa pine and Apache pine, is under mass-production by the Forest Service on the east side of the Cascade Mountains in Oregon. Its performance in that region is unknown; but on the basis of early results of tests in California, it is expected to surpass ponderosa pine in growth rate.

AIMED BREEDING PROGRAM LAUNCHED

For commercial production, tree breeders try to select as parent trees those forms that are well adapted to the planting locality and to the commercial use for which they will be grown. This is aimed breeding, which at present is little more than an exceedingly important concept based on the fact that widely distributed species exhibit great inherent variability. Relatively little is known about inherent geographical variation. Consequently the process of trial and error plays a big role in breeding for particular locations. Its role can be reduced by applying knowledge gained from studies of racial variation and from field tests of hybrids produced through crossing different races of the parental species.

We are conducting such studies, one with a grant from the Forest Genetics Research Foundation, and in time information from them will contribute much precision to aimed

breeding. Meanwhile we have started breeding hybrids of different geographical lineage for subsequent field testing.

Early this year our geneticists collected pollen and seed of knobcone pine, which is a parent of one of our most impressive hybrids, from 43 different stands. These stands were distributed over most of the wide range of the species--from southern Oregon to the Mexican border, from a few hundred to 6,000 feet in elevation, and from hot dry slopes to moist meadows. The pollen will be used to produce hybrids of different endowments between Monterey and knobcone pines. They will be tested in many different localities to bring out some of the potentialities in each source of pollen. The seeds will be used to produce conveniently located breeding orchards where the hybrid can be produced in abundance at minimum cost. Each year we plan to concentrate in this manner on one of our most promising hybrids.

In 1958, the Jeffrey-Coulter backcross hybrid, now in considerable demand, will be one of our targets. This hybrid is made by pollinating conelets of Jeffrey pine with pollen from natural hybrids between the two species. In cooperation with the California Region of the Forest Service, we made an intensive search last summer for these natural hybrids and found many in the forests of coastal and southern California, where the two species occur in mixture. Pollen will be collected from them next spring and used in producing the backcross. Thus, in time, the breeding potential of the various pollen parents can be determined. We may find that the backcross progenies of one hybrid may be noteworthy for cold resistance; those of another may excel in resistance to the destructive pine reproduction weevil. Results of this procedure should enable us to determine the most suitable parental combinations for particular sites.

SEARCH FOR NEW HYBRID COMBINATIONS CONTINUES

To broaden the base for aimed breeding, we are energetically extending our search for more promising combinations among the pines. In effect, this is a reconnaissance of the hybridization possibilities within the genus. We are trying to learn through systematic trials, which species and varieties of pines combine readily, which do not, and the

character of the hybrids produced. As in chemistry, knowledge of combining affinities and the nature of resulting compounds is basic to the highest economic development of the available raw material.

Over the years we have produced about 80 different hybrid combinations; but since no one is certain of the needs of the future, no one can set a limit to the potentialities of the breeding process. Some untried combinations in the rich heredity of pines may render the best of existing forms obsolete through the production of still better forms. This year, the second in a new 5-year reconnaissance program, we attempted 71 new crossings between species and varieties of pines. More than 600 pollination bags were used in this effort.

BIOCHEMICAL STUDIES AID UNDERSTANDING OF FLOWERING

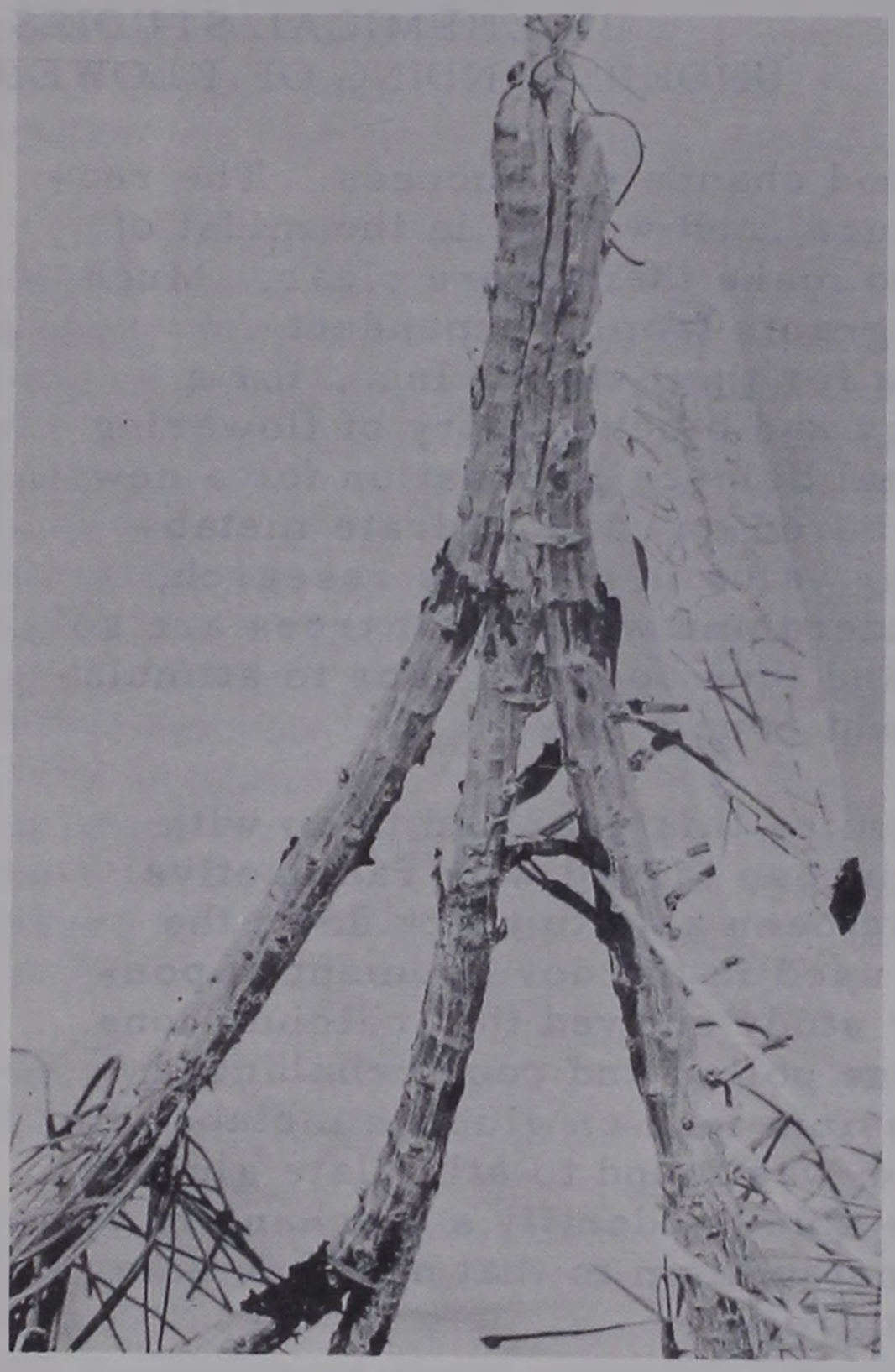
Some attempted crossings fail even though the genetic relationship between parental forms suggests a good chance for success. The reasons for the failure are obscure, and we are in the midst of some basic studies seeking to make them more clear. Much of this work is supported by grants from independent foundations--from Resources for the Future, Inc., for a 5-year study of the physiology and biochemistry of flowering in pines; and from the National Science Foundation for a new 2-year study of the effect of boron on carbohydrate metabolism in pines. Besides their value in genetics research, these studies may help us understand why forest trees are so variable in seed production and thus open the door to stimulation of larger or more frequent cone crops.

Most of the flowering studies this year had to do with pollen metabolism. Using glucose tagged with radioactive carbon, our biochemists have been able to track down the pathway by which glucose is used in the development of ponderosa pine pollen. Another study showed that calcium ions stimulated germination of pine pollen and counterbalanced the inhibitory action of potassium ions on glucose metabolism in pollen-tube growth. Boron was found to stimulate glucose metabolism. Also, we were able to identify a mechanism by which pollen may adapt its metabolism to that of the female plant tissue on which it must grow.

How are these findings to be used? It is probably too early to say, particularly in the middle of a biochemical investigation, but one suggested application is through chemical conditioning of metabolic pathways so as to eliminate barriers to hybridization.

One of the objectives of the flowering study is to learn more about the biochemistry of male, female, and vegetative buds of pines. In this year's work, we looked for differences in the micro-element or gross nucleic acid components of such buds in knobcone pine, but found none. The study has yet to assay the situation in shoots when the flower buds start to form.

An attempt to induce early flowering in pines was made by providing a single leader with additional root systems through successfully making several approach grafts on the same stem. This technique carries other important implications, among which is the possibility of intensifying a specific effect of a particular stock on a scion.



Three root systems grafted to single pine seedling.

Gibberellin, which has proved a spectacular plant-growth stimulant in some studies, was tested for capacity to overcome the dormancy of buds and roots in ponderosa pine and south Florida slash pine, but results thus far have been negative.

We are also testing the possibility of stimulating the development of transplanted pine seedlings by exposing them to continuous light during the first 6 to 8 months of their development in a greenhouse. The stimulative effect of the treatment appears to be specific. For example, the vigorous hybrid of lodgepole pine and jack pine showed less response than the more slowly growing white pine.

NEW TOOLS SPEED UP EXPERIMENTAL WORK

There is no point whatever in attempting crosses with dead pollen. But you cannot tell if pollen is dead or alive by looking at it. Tree breeders therefore have to test the viability of pollen before using it, and this is a time-consuming process--the tests may take from a couple of days to 2 weeks.

We have now developed and partially tested a new method that checks pollen viability in 2 hours. The method colors live pollen pink or red but does not stain the dead pollen. (The staining material is 2, 4, 5, tri-phenyl tetrazolium chloride.) If this process, now in the final stages of development, proves successful, it will eliminate most of the work and time expended on pollen germination tests.

Another time-saver is in the first stages of development. This is a rapid method of analyzing pine turpentine by use of gas chromatography. The apparatus is extremely sensitive, and because we have completed an inventory of pine turpentines by conventional fractional distillation, we have the necessary body of comparative data to permit interpretation of charts produced by gas chromatography. We estimate that this method could reduce the time for a single analysis from several weeks to about half an hour.

FOREST PRODUCTS UTILIZATION RESEARCH

INTEREST IN PULPING LEADS INDUSTRY TREND

Only a few years ago, wood chips for pulp use were a rare commodity in California's forest-products markets. Now it is common to see freight cars and trucks loaded with chips on their way to the pulp mill. These loads symbolize a trend that has been building up noticeably in recent years--a swing toward more integrated, more intensive utilization. It has been sparked by an active interest in greater wood pulp production.

One of the large pulp plants in the State operates entirely on wood chips, and the other gets the greater part of its raw material from this source. This past year still more veneer plants and sawmills installed log debarkers and slab chippers to take advantage of this trend. Hundreds of tons of plant residues are moving to pulp and particle board uses each day.

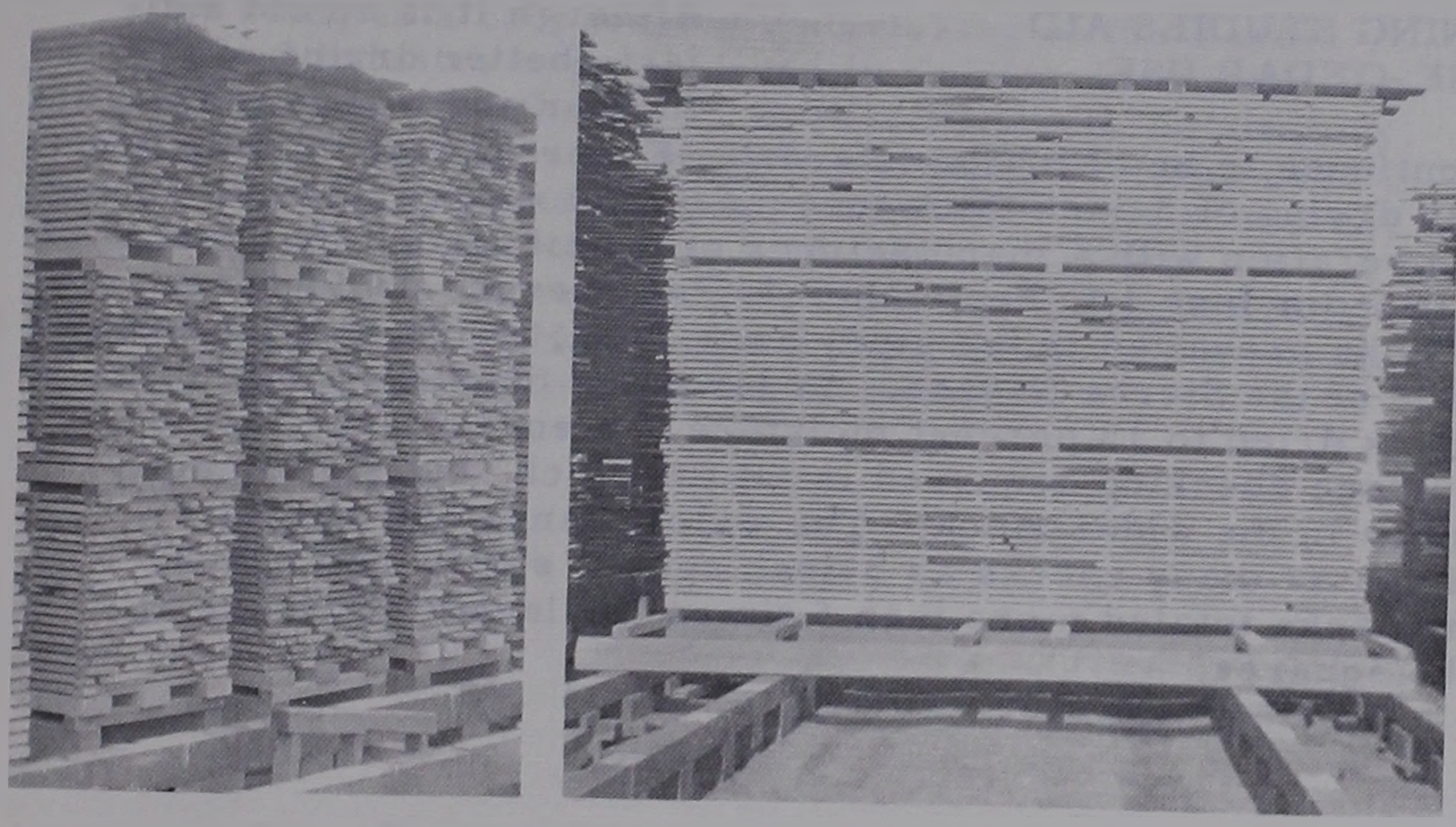
This use, besides increasing the employment potential of the forest industries, is a conservation measure. It represents a positive economic return from wood once destroyed in the burner. It relieves the drain on the timber resource and provides an outlet for low-grade logs that otherwise would be submarginal in value. As the pulp industry develops--and there is a definite interest in more pulp operations--these benefits should increase.

Information that can aid in development of the industry was published late in 1957. This is the report on a cooperative study of the pulp and paper resources of California with special reference to waste treatment and disposal, which we mentioned last year. Published by the California State Water Pollution Control Board, this report includes the findings of several Federal, State, and industry groups. It contains technical data on the wood resource, pulping processes, water supply and requirements, waste characteristics and pollution-control measures. The report should be of value to everyone interested in any phase of the subject.

More information on raw material potentialities is becoming available, too. To supplement its work on pulping of redwood, the U. S. Forest Products Laboratory began this year some cooperative studies of the pulping characteristics and paper-forming qualities of several local hardwoods, particularly oaks. The increasingly important place that hardwoods are taking in the pulp and paper industry, based on Laboratory-developed high yield processes, demonstrates that they should be included in plans for a developing pulp industry here in California.

NEW STUDIES SEEK USES FOR LOCAL HARDWOODS

Hardwood timber stands also received greater attention this year as a possible source of raw material for lumber and plywood products. The Station and the U. S. Forest Products Laboratory took part in a comprehensive study of the utilization prospects of California black oak in cooperation with a local company which owns and operates a large acreage of timber containing substantial volumes of black oak. The Laboratory studied log grades, lumber-grade yields and the resultant values, and the potential veneer values. We were concerned mainly with the drying of black oak lumber, particularly the feasibility of hastening the process by employing a "predrying" technique. This technique involved drying green lumber at relatively low temperatures in a kiln compartment to a moisture content at which it can safely be subjected to the usual dry kiln conditions.



End and side views of black oak lumber piled for seasoning experiments.

The results of the study showed that 1-inch oak can be dried to a moisture content of 20 percent in about 30 days without seasoning degrade. Subsequent kiln drying of the lumber corroborated earlier findings that black oak entering the kiln at a moisture content of 20 percent or less can be dried to a moisture content of 6-8 percent without difficulty.

We also worked closely with the University of California Forest Products Laboratory in a basic study of some of the more fundamental factors of shrinkage and behavior of the green wood in drying.

Interest in another use for hardwoods--to make charcoal--appears to be maintained on a high level. One reason lies in the Station's production survey which showed that charcoal production from all sources was probably only one-fourth the consumption in local markets.

We have received many inquiries about the possibility of increasing production. Some of these inquiries relate to sources of wood, others to kiln construction and processing techniques. Judging from the sources of some of the inquiries, larger installations for producing charcoal may come into the picture here in California. The high cost of shipping charcoal into California from the east, and the active local consumption favor larger production here.

SEASONING STUDIES AID INCENSE-CEDAR USE

Although it is an old subject, better drying of lumber and wood products continues to be of major interest. Experimental work in the air drying of 3-inch thick incense-cedar was carried on in cooperation with a manufacturer of pencil slats. The test ran from June 1 to September 15, and severe drying conditions prevailed in the study area, at 3,000 feet on the west side of the Sierra Nevada. Under these conditions, all of the stock dried to 15 percent moisture content or less. Some surface checking occurred in all the stock, but significantly more in the wider stock. The wider planks had almost 4 times as many checks as 3-inch square stock, and checks in planks totaled more than 5 times the length of checks in the squares.

A similar study was started in the fall to determine effect of pile spacing and position in the pile on rate of drying and occurrence of seasoning checks during the less severe drying periods of the year.

We cooperated again with the University of California Forest Products Laboratory in presenting a course in lumber drying attended by 17 enrollees from industry organizations, sawmills, custom dry kiln operations, wholesalers and other groups.

LUMBER RECOVERY COMPARED IN NEW LOG GRADE STUDY

What kind of lumber can be sawn from different grades of logs? The answer to this question is of interest to both wood-using industries and timber growers. This year we helped plan and conduct a study seeking some of the information needed to provide an answer for ponderosa pine and sugar pine.

In this study the logs were first graded and then sent through the sawmill of a cooperating firm. The lumber from each log was graded and marked so it could be followed through other manufacturing steps to determine the quantity and quality of material recovered from the various log grades. Since the lumber samples must be followed through both kiln-drying and air-seasoning operations, final data will not be collected for several months.

The study is a cooperative undertaking of the Forest Service and industry organizations in California and the Pacific Northwest, and the U. S. Forest Products Laboratory. One aim is to check the existing log grading systems used in the two western regions. Also, this work is part of a study of the practicability of setting up a uniform log-grade system for pine over a wide range of growth. Ideally, a single grade classification would serve for ponderosa pine throughout the west. Whether this is possible remains to be seen.

FOREST FIRE RESEARCH

Increases in Federal and State funds gave us a real opportunity to step up fire research in 1957. We were able to concentrate more research in southern California, to intensify some of the activities that have been on a small scale, and to start some new projects.

NEW FUEL-BREAK PROJECT STARTS IN SOUTHERN CALIFORNIA

One new project, called Fuel-Break, is seeking ways to ease the fire fighter's task and cut down the few large fires that cause most of the damage in southern California watersheds. Ninety-eight percent of the watershed fires starting on the 4 national forests in southern California between 1951 and 1956 were held to less than 1,000 acres. They caused relatively light watershed damage and cost relatively little to fight. But what of the remaining 2 percent?

Disasters like the Monrovia Peak Fire of 1953 and the Malibu Fire of 1956 can set watershed management plans back 75 to 100 years. The Gale Fire on the Angeles National Forest in November 1957, for example, may cost more than $25,000,000 in damages, and the federal fire-fighting bill alone may exceed $500,000. No fire-fighting force now known can stop these fires once they have begun to roll. They run wild ahead of strong, dry northeast winds and usually slow down only when the weather changes or natural or man-made barriers block fire spread.

Each year the water yield from these mountains becomes more precious. Each year more homes and industries are vulnerable to fire and flood. Southern California cannot afford these disastrous fires, but what can be done to stop them? We cannot change the "unusual" weather conditions which give birth to Santa Ana winds, but can we change the fuel--modify the highly flammable chaparral at strategic locations?

Fuel-Break was created to help find some of the answers to this provocative question. It aims to develop methods of treating vegetation on wide strips or blocks so as to establish plants of low fuel volume, reduce flammability, or both. Since wild fires have no respect for property lines, Fuel-Break, like Operation Firestop, was organized as a cooperative program.

Work of the program leader, who represents the Station's Range Management and Forest Fire Research Divisions, is guided by an Executive Committee including members of the California Division of Forestry, University of California, Los Angeles County Fire Department, Los Angeles County Watershed Commission, and the Forest Service. This committee held its first meeting in Los Angeles November 20 to organize and lay plans for the future. Though this research is started in southern California, its results should have wide application.

CAN OPERATIONS RESEARCH HELP SOLVE FIRE PROBLEMS?

Fire fighters know that the objective of forest-fire suppression is fast control of all fires at a reasonable cost. To keep costs down, they must walk a tricky tightrope--fitting the attack force to the potential fire danger yet always dispatching enough initial strength to suppress the fire quickly and safely. If they send too small a force and initial attack fails, costs mount; if they send too many men or too much equipment, they may overwhelm the fire but waste money.

The difficulty is that few fire bosses and dispatchers know just the right combination of men and equipment for each fire. Furthermore, the rapid development of air attack has complicated their job by providing a new specialized tool that must be coordinated with more conventional means of suppressing fires.

Operations research may help us match available tools to the many fire-control tasks. This technique helped military forces find the best combinations of aircraft for defense and counter-attack during the Battle of Britain. It taught Korean forces how to come up with the right combinations of men and equipment. Today business leaders use operations research to help solve complex industrial problems: they are finding ways to speed up production, eliminate transportation bottlenecks, and increase profits. We believe the same techniques can be used successfully to solve complex initial attack problems on forest fires.

We have hired a mathematician for this project. He is assigned to our Glendora headquarters and will spend most of his time during the first year establishing contacts with operations research workers and fire-fighting agencies in southern California. His next job will be to work with fire fighters on a problem analysis of initial attack systems now in use.

FIRE-PREVENTION RESEARCH SPEEDED UP

The California Division of Forestry and national-forest resource managers have joined the Station in our cooperative fire-prevention research program with the University of Southern California. Consequently, we were able to step up efforts to develop questionnaires designed to test the fire-prevention knowledge of such forest users as campers, fishermen, hunters, and forest residents. This test, similar to the State drivers' examination, aims to learn what these special groups know about fire prevention and what they do with this knowledge. We field tested the questionnaires with the help of the Eldorado, Modoc, and Plumas National Forests. Later they were revised to meet the special requirements of the California Division of Forestry and are now ready for testing in State-protected areas. Two other studies also were started: an analysis of the fire-prevention material in outdoor sports magazines and an evaluation of fire-prevention material in public school textbooks.

Can the number of lightning fires be reduced by cloud seeding? What effect does this seeding have on rainfall in the thunderstorm area? These are some of the questions we are trying to answer through a new cooperative project with the California Division of Forestry. In an effort to get more data on how seeding affects thunderstorms, the state operated a total of 50 ground generators producing silver iodide crystals during the summer of 1957. These burners were distributed over a 6,000-square-mile area in northeastern California, including parts of the Lassen and Plumas National Forests. In addition, four airplanes based at Petaluma, Rohnersburg, Arcata, and Willows disseminated silver iodide under threating cumulus clouds over the Mendocino, Six Rivers, Shasta-Trinity, and Klamath National Forests and adjacent areas protected by the California Division of Forestry.

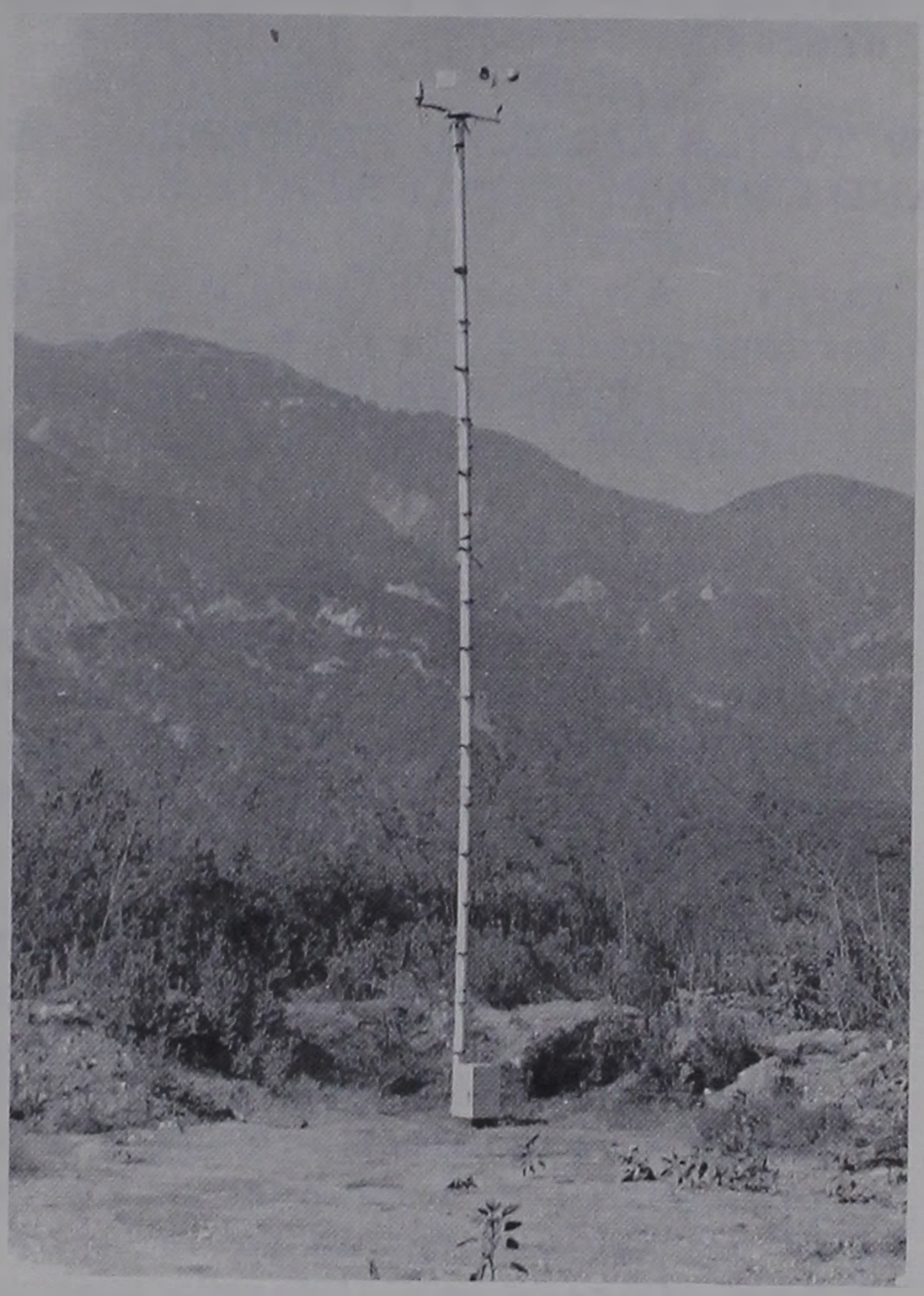
This was a light year for thunderstorms throughout California, but a preliminary review of seeding results indicates that the number of lightning-caused fires on the test area was even farther below average than in adjacent untreated areas. Though local observers are enthusiastic about their observations of cumulus cloud modifications during tests, over-all reductions in lightning-caused fires were not statistically significant for the sample analyzed to date.

We are continuing to maintain close liaison with Project Skyfire, which is studying the possibilities of lightning-fire prevention in Montana. A joint work conference of Skyfire personnel was held in Berkeley during December to review progress and plans for the future.

FIRE BEHAVIOR STUDIES SHOW WIDE GAPS IN KNOWLEDGE

Again this year task forces from the Division of Forest Fire Research studied fire weather and fire behavior on several large fires. Their observations emphasize the need for better knowledge of local fireclimate and of the interaction of fireclimate, general weather conditions, and the behavior of the fire. It was apparent, too, that fire fighters need more quantitative information on the way fuel conditions affect the spread of fires--and more fire-behavior specialists to apply this information on wildfires and prescribed burns.

Because of these needs, we decided to strengthen the Arroyo Seco fireclimate survey on the Angeles National Forest when additional funds became available this year. From previous work, we knew that a more detailed picture was needed to show the variations in wind, temperature, and humidity that affect fire behavior in this rugged canyon, so we set out a finer network of observation stations and extended measurements into the season's first severe Santa Ana wind condition. These additional data complete the field work for the Arroyo Seco fireclimate survey. The mass of data accumulated during the past 2 years now needs to be analyzed.



Recording instruments in towers trace variations in fire-weather.

Usefulness of a short-term wind survey on prescribed burns was given a more extensive test in cooperation with the California Division of Forestry and private landowners. We surveyed 4 prescribed burns, varying from 100 to more than 1,000 acres in size. To give the fire boss a better picture of burning conditions, the survey crew recorded wind direction and speed, temperature, and relative humidity for a week to 10 days before each burn. Then just before the time for ignition, they prepared a detailed fire-weather forecast from these local observations and knowledge of general weather conditions. It was plain that the ignition plan on prescribed burns must be carefully timed to take advantage of favorable winds along different sectors of the fire edge. These surveys also have shown that when prevailing winds tend to blow at right anges to major drainages, wind patterns in the burn may be extremely complex, and the risk of spot fires outside the burn is greatly increased.

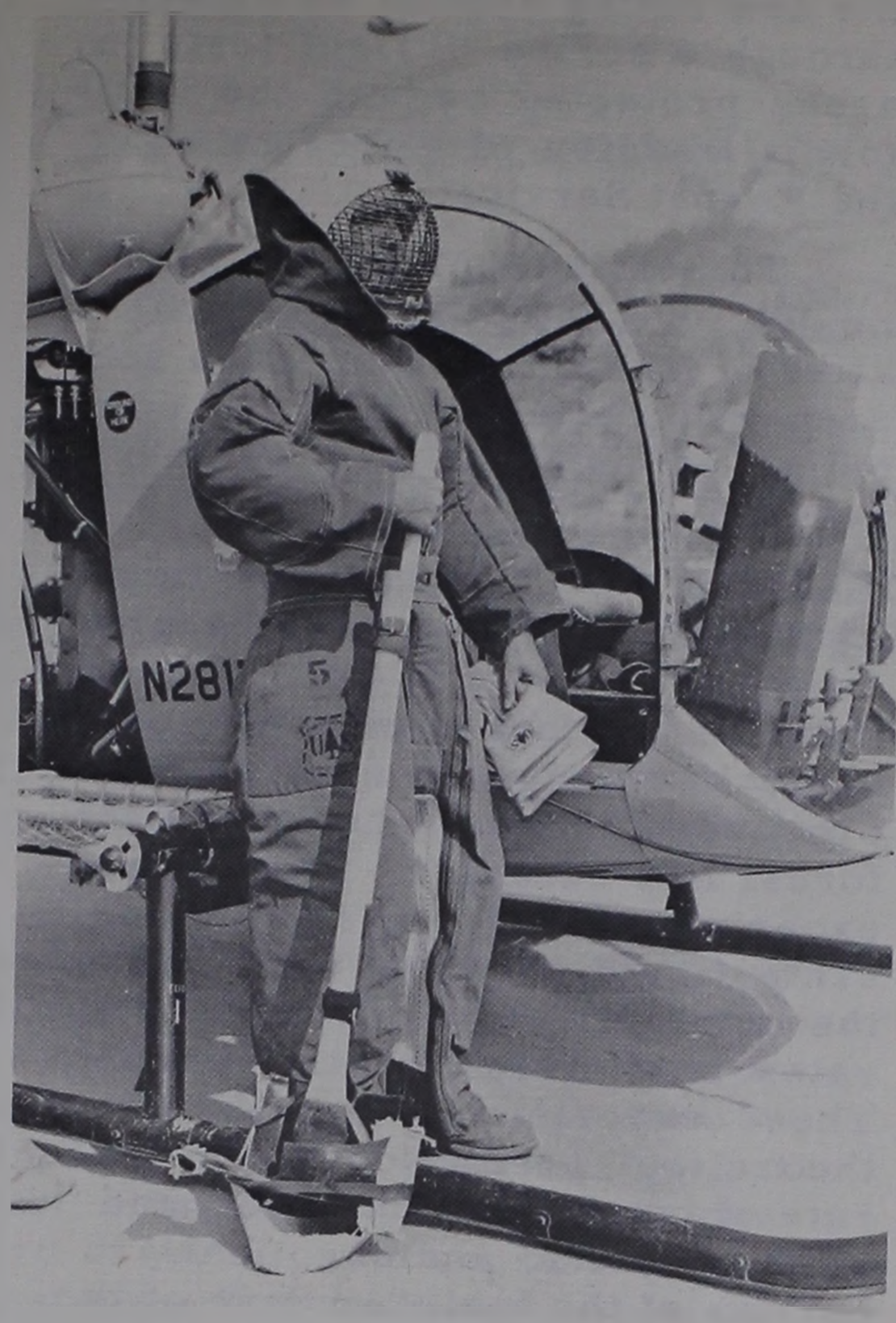
NEW TOOLS AID FIRE FIGHTERS --AND CREATE NEW PROBLEMS

New air attack tools introduced to fire fighters in 1956 brought many advantages. Air tankers dropping water and chemical fire retardant checked the flames until ground forces could assure control. Helicopters proved that besides transport and scouting jobs, they could handle hose-laying chores from the air.

But these new tools also produced some new complications. Air tankers and helicopters almost collided in the smoke; air tankers sometimes dropped their load where fire retardants could do little good. Fire bosses had little or no control over the air attack because of poor communications or lack of coordination.

To study ways to use air attack most effectively, Station staff men met with representatives of fire agencies and the U. S. Navy early in 1957. They specified the air control required under different fire situations, and developed an organization designed to give the fire boss the tight control and good communications he needed. The Station, the California Division of Forestry, and national-forest officers in California also conducted a review of air attack methods for western fire fighters in Redding in April.

These efforts were helpful, but after reviewing air-attack developments in 1957, it is obvious that still better guidelines are needed for the new tools. Take air tankers, for example. (They were bigger this year: Navy TBM's and PBY's were adapted to carry 4 to 15 times as much water or fire retardant as the small biplanes used in 1956.) They dropped nearly a million gallons of water and chemicals this year, and though air-tanker operations were successful in many parts of the West this year, they were sometimes used under conditions when conventional ground equipment could have done the job as well or better.



Protective clothing for Helitack crewmen.

One answer to these problems may be intensive, specialized training of air-attack units. We helped give this kind of training to helicopter crews as part of the program this year. We think the effort paid off; helicopter-borne fire fighters made the first attack on about 50 fires in California this year and assured control on more than half of them. When landing spots for helicopters were not available, these specially trained men, clad in protective clothing, could jump from a hovering helicopter to a spot near the edge of the fire.

STATE-WIDE FIRE DANGER RATING SYSTEM EXTENDED

For a long time, the major fire-fighting agencies in California have used widely different systems to rate the fire danger on a given day. In the past 2 years we have been working with these agencies to develop a single system that could be applied throughout the

State. This year a pilot model of the new rating system was started through a series of field tests in areas protected by both the California Division of Forestry and the Forest Service.

To help in applying the pilot model, we compiled a climatic atlas of fire-protection zones and prepared a simpler form for computing an index to fire-weather severity.

MODEL FIRES AID FIRE PHYSICS STUDY

In our fire physics program, we continued our effort to develop some basic knowledge of combustion processes that will help predict forest fire behavior. This year's experimental work used 148 small-scale liquid hydrocarbon fires in the laboratory to study combustion rates from free burning surfaces. These experiments corroborated theoretical predictions that the rate of combustion is influenced by the physical and chemical properties of the fuel, the size of the burning area, and the fuel temperature. The next step is to extend these results to a well established wood fire. Here we probably need to separate two effects of relative humidity on rate of combustion--a direct, and probably the greater, effect in the combustion zone, and an indirect effect expressed by the moisture content of the wood. To separate these two effects, we have designed an apparatus for continuous burning of small-scale wood fires. This will permit the fuel to be conditioned to any moisture content desired just before burning.

Model fires provide experimental data to test combustion theories.

"Project Civil" in cooperation with the University of California Department of Engineering and the Federal Civil Defense Administration, has been continued. This project seeks to determine the influence of fire-induced convection columns on the deposition of fallout. In another cooperative defense project, we assisted the U. S. Army Engineer and Research and Development Laboratories of Fort Belvoir in measuring the effectiveness of a radically new fog-dispensing device developed as an Army fire-fighting weapon.

FOREST INSECT RESEARCH

DAMAGE FROM FOREST INSECTS INCREASES IN CALIFORNIA

Forest insects did considerably more damage than usual this year over the State as a whole. Bark beetles, in particular, took a greater toll in both timber-producing and recreation forests. Defoliating insects stripped trees in some areas, game-browse plants in others. Cone and seed insects virtually eliminated this year's scant coniferous tree seed crop as a natural source of regeneration. Outbreaks of several lesser insects hit plantations, and for the first time the possibility of serious damage from insects foreign to California's forests became imminent. These are the highlights from forest insect surveys conducted by the Station.

We were able to put more effort into the surveys this year, for on July 1 the Regional Office of the Forest Service took over our former job of technical supervision on insect control projects. Furthermore, the number of insect detection reports received from cooperating foresters nearly doubled this year, rising to about 220. Our entomologists made on-the-ground appraisals of nearly one-third of these, with the help of Federal, State, or industry foresters. We conducted aerial insect detection surveys in the spring and the fall. And we furnished land-managing agencies and private owners with reports of our findings.

TIMBER DAMAGE. Mortality due to bark beetles increased most in the mixed-conifer belt on the west slopes of the Sierra and in the ponderosa-Jeffrey pine belt on the east slopes. Three species of pine bark beetles accounted for most of the increases: the western pine beetle in ponderosa pine, the Jeffrey pine beetle in Jeffrey pine, and the mountain pine beetle in sugar pine.

In the mixed-conifer type, losses were generally upward, but markedly so around some of the areas burned 2 years ago, like the McGee Burn in Fresno and Tulare Counties and the Haystack Burn in Siskiyou County. Near these two burns alone beetles breeding in fire-weakened trees spread into surrounding green timber and killed thousands of trees containing several million board-feet. Prompt salvage cuttings around some burns helped forestall losses from this cause to some extent.

Outbreaks of pine bark beetles (inset) in timber surrounding a burn often occur a year or two after a fire. Logging fire-weakened trees, which are beetle susceptible, coupled with measures to control infestations in trees that cannot be logged, helps to forestall the outbreaks.

In the ponderosa-Jeffrey pine type, losses were greatest in old-growth stands where neither harvest nor sanitation-salvage cuts had been made. On the Blacks Mountain Experimental Forest in northeastern California, for example, beetles killed 207 board-feet per acre on untreated compartments, but only 56 board-feet per acre on those treated by sanitation-salvage.

Damage from pine engravers was light this year and infestations scarce. Fir-engraver outbreaks in true firs were sporadic statewide, and losses about normal. The Douglas-fir beetle in northwestern California showed some signs of breaking out, after reaching a comparatively low level last year but damage was low.

RECREATION FORESTS. Insect problems continued to mount in some forest areas managed primarily for recreation. In lodgepole pine, high in the South Warner Mountains, Modoc County, the mountain pine beetle outbreak discovered last year continued to rage unabated. In mixed-conifer stands around Pinecrest, Tuolumne County, the mountain pine beetle in sugar pine and the western pine beetle in ponderosa pine caused serious damage. Bark-beetle losses in this same timber-type also increased in Yosemite National Park.

In the Tuolumne Meadows area of the Park, the mountain pine beetle and its forerunner, the lodgepole needle miner in lodgepole pine, were more numerous and destructive than at any time in recent years. These two pests again killed much old-growth lodgepole around Tuolumne Meadows.

In Sequoia-Kings Canyon National Park, pine bark beetles destroyed many fine sugar pine and ponderosa pine in and around Grant Grove. This outbreak is one of those that developed as an aftermath of 1955 fires in nearby timber.

Jeffrey pine on the Mt. Laguna Recreational Area, San Diego County, was beset by a multiplicity of pests, both insects and diseases. Many trees were killed completely; in others, large parts of the crowns were killed. The California flatheaded borer was the insect most frequently found in the dead and dying trees, but its role was not clear cut.

PLANTATION PESTS. Pests of plantations and young growth were both abundant and destructive. Pine sawflies defoliated trees in several plantations in the northern part of the State. One known outbreak of the pine reproduction weevil at Mt. Shasta was controlled with aerial spray, but a new infestation was discovered on the Eldorado National Forest. Native tip moths that attack and kill lateral and terminal buds of some pines caused considerable damage. The needle-sheath miner, a defoliator, was epidemic in pine plantations at the Institute of Forest Genetics. These and other native pests added to the difficulty of growing forest crops.

INTRODUCED INSECTS. Introduced forest insects became a problem in California this year; hitherto, native insects have been our main concern. One newcomer was the spruce needle miner. This insect was discovered in planted spruce in Modoc County by State entomologists who attempted to eradicate it.

Because of the scarcity of native spruces, the needle miner probably will not become a serious forest pest; but it may prove troublesome on planted spruce stock. One other introduced forest insect, collected in California many years ago, may constitute a new threat to true-fir forests. This is the balsam woolly aphid, a pest currently doing extensive damage in the Pacific Northwest. Our entomologists made a special survey for this insect in northwestern California but found no current infestations.

RESEARCH PAYS OFF IN CURBING LOSSES

Application of the results of research helped keep the upward trend in insect damage from reaching higher levels than it did. The absence of more extensive bark-beetle outbreaks in the ponderosa-Jeffrey pine belt, for example, can be accounted for by the widespread use of sanitation-salvage to "bug-proof" such stands.

Direct-control techniques developed through research, such as salvage-logging infested trees or falling and spraying such trees with penetrating oil sprays, were used extensively in suppressing this year's rash of bark-beetle outbreaks. Similarly, with defoliators, insecticidal methods worked out by research were used effectively in checking some of the damage.

Our entomologists helped land-managing agencies and private owners put research findings into use, and advised them on the entomological aspects of insect control programs.

RESEARCH BEGUN ON DOUGLAS-FIR INSECTS

In California less in known about the role of insects in Douglas-fir silviculture than in pine. Sporadic outbreaks of the Douglas-fir beetle have killed much timber from time to time, but the damage has seldom been on a scale comparable to that caused by bark beetles in pines. We do know that other insects besides bark beetles can be a major obstacle in growing timber crops. Foresters believe this to be the case in the management of Douglas-fir in northwestern California. There the principal culprits are insects that destroy cones and seeds, preventing successful regeneration of this species. To help solve these problems, the Station started some new entomological studies this year in the northwestern part of the State.

One of the first steps is to develop adequate facilities for field work. To this end, the Six Rivers National Forest helped us select a site near the Orleans Ranger Station, Humboldt County. Here studies commenced and planning for site development began early in July. Our new studies dovetail with comparable research on cone and seed insects in pines being conducted by University of California entomologists.

We know from past surveys that Douglas-fir cone and seed insects are extremely destructive in some years, less so in others. Insect damage to the bumper seed crop in 1956, for example, was nominal. In samples we collected, only 16.5 percent of the cones and 0.4 percent of the seeds were infested. In 1957--when the cone crop was scanty and seed for reforestation badly needed--insects destroyed almost all of the seed produced.

Knowledge of the pests responsible for poor Douglas-fir seed crops is comparatively scarce. The identities of a few species are known; most are not. Some of the unknown ones are probably new species yet to be described. We know little about the amount of damage done by the different species or even by different groups. And with one or two exceptions, the habits of most of these insects are poorly understood. The axiom that effective control of insect pests is predicated on sound biological knowledge is as true for cone and seed insects as it is for other groups. The goal of research we have begun is to develop the necessary knowledge and, in time, develop effective control measures to combat these pests.

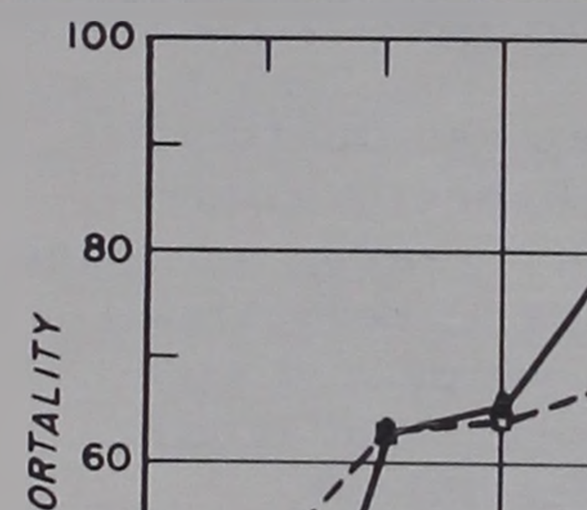
FIELD TESTS OF RESIDUAL SPRAYS SUPPORT LABORATORY FINDINGS

Nowadays every home owner knows that certain chemicals will kill insect pests long after the sprays are applied. These residual-type insecticides are also a promising tool for bark-beetle control. In a series of laboratory tests over the past few years, we found that some chemical deposits killed bark beetles at very small dosages. Also, their toxicity varied with the shape and size of microscopic crystals formed by the desposits. But laboratory tests are a long way from conditions in the forest.

This year we started field tests, and the first results suggest that laboratory results are on the right track. To simulate normal beetle-control practice, entomologists sprayed logs known to be infested with bark beetles. These logs were placed in cages where the beetles could mature. As the beetles emerged, they crawled onto the sprayed bark and then flew to screen sides of the cages. Entomologists collected them to see how many would die from their brief exposure to lethal crystals on the bark

surface. Other infested logs were not sprayed, and the beetles were reared and collected in the same way to check their death rate.

Mortality was much higher among beetles reared in sprayed logs. And in these field tests as in the laboratory, crystal structure proved important. The most toxic deposit was composed chiefly of broad, plate-like crystals, shown magnified 54 times in the center photograph below. This structure resulted from a spray concentration of 640 mg. per square foot of bark surface; 1,280 mg. (at right) crystallized into isolated clumps, which proved less toxic than evenly distributed crystals; and 320 mg. (at left) formed well distributed, but mostly short and needle-like crystals--also less toxic than the thick plates, as the accompanying chart shows.



NATURAL CONTROL FACTORS AFFECT LODGEPOLE NEEDLE MINER ABUNDANCE

Research has produced new clues to natural factors that affect the abundance of the lodgepole needle miner. It has also provided some promising new leads to chemical methods of controlling this pest. And surveys have disclosed further extensions in infestation areas apart from those previously known to exist. These are the chief results of studies we have been conducting at Tuolumne Meadows, Tuolumne County, in cooperation with the National Park Service.

Yosemite and Sequoia-Kings Canyon National Parks have been the scenes of periodic needle miner outbreaks for many years. The most devastating outbreaks have occurred in the upper Tuolumne and upper Merced River watersheds of Yosemite. The latest to develop there began about 10 years ago, near Tuolumne Meadows. Since then, the infestation has increased and spread until now it is the most extensive single infestation in the State.

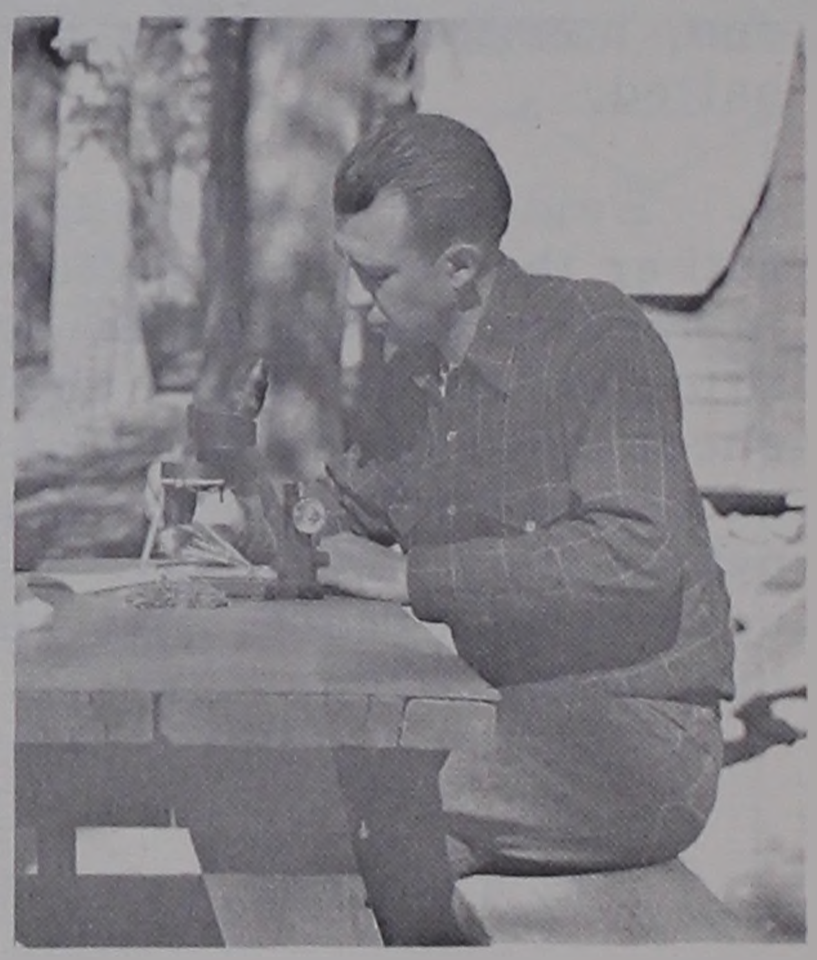
Widespread killing of lodgepole has been the result of these outbreaks. Many trees, stripped of their foliage by needle miner feeding, have died from the effects of defoliation alone. A great many others, weakened by partial defoliation, have become breeding grounds for the mountain pine beetle. The result is that the beetle is also epidemic. The two pests together have killed entire stands of lodgepole and threaten to kill others. Research which we began 4 years ago is seeking to find out why these outbreaks occur, what factors normally bring them to an end, how these factors operate, and how epidemics may be halted.

Evidence to date suggests that a combination of factors, rather than any one factor alone, probably controls fluctuations in needle-miner abundance. One of the combinations is competition for food. When entire stands of lodgepole are stripped by successive generations of needle miners, the foliage supply usually dwindles to the point where the larvae run out of food before they can complete development. A few subsist on abnormal host trees, like red fir, hemlock, and white bark pine, but most starve.

Another factor that affects abundance is needle fall. Mined needles are easily blown to the ground by wind, or knocked down by rain or hail. This often happens when the insects are in the late larval or pupal stages. Less than 5 percent of the needle miners in fallen needles are able to reach the adult stage. Wind and rain also influence strongly the action of the adults. Storms and strong winds keep the moths from taking wing, but gentle breezes help them migrate and disperse.

Natural enemies also take their toll. An inventory which we made this year showed that the needle miner is host to a great many parasites and predators. Among the

Foliage of needle miner-infested lodgepole pine is sampled periodically with pole pruners, and samples are examined under a microscope to study development of insect or effects of control.



parasitic species is a small encyrtid wasp that may become an important natural control factor. This wasp is a polyembryonic parasite, having the capacity to produce many individuals from a single egg. It has been turning up with increasing frequency in our studies, and was 3 times as abundant this year as all other parasites combined.

A practical method of controlling the needle miner with insecticides has been the goal of much of our research. Several different chemicals that control other insects have been tried and found wanting against this pest. Most promising to date is malathion, which we first tested about 2 years ago. Since then, several formulations and different methods of applying them have been tried against both the adult and larval stages. No treatment so far has given the high degree of kill needed to reduce needle-miner populations to acceptable levels. However, we have found that comparatively high doses--2 pounds of malathion in 20 gallons of diesel oil per acre, will kill about 75 percent. We also learned that the larvae are more readily killed with these doses than the moths. In addition, our tests have demonstrated that spraying with modern-day helicopters is practicable in the rough and high terrain where needle-miner outbreaks now occur.

FOREST DISEASE RESEARCH

During the first full year that forest pathologists have worked together as a Station Division, emphasis has been given to coordination of survey, control studies, and research. We know that an effective balance must be maintained among these three activities if we are to cope successfully with statewide disease problems. Furthermore, we expect that the number and complexity of these problems will be increased by the intensive use of forest land by California's growing population. With these needs in mind we increased the scope of disease survey, maintained previous level of control investigations on white pine blister rust, and started new research on heart rots and dwarfmistletoes.

The University of California gave substantial impetus to disease research by appointing a forest pathologist to the faculty of the Department of Plant Pathology at Berkeley. To maintain close and effective work contacts between the University and the Station, we appointed him a Collaborator and the University designated one of our staff as a professional associate of the Department of Plant Pathology. The California Forest Pest Control Action Council continued with its helpful support of disease survey, research, and control as part of its over-all interest in better pest control in California forests.

SURVEYS HELP FOREST MANAGERS

Forest disease surveys serve three essential needs of forest managers. They provide a statewide cooperative service for detecting and reporting all types of diseases; they provide case histories on the effectiveness of control for specific forest diseases such as white pine blister rust; and they furnish accurate information about disease losses in our timber resource.

Survey activities of 1957 do not reveal new or unexpected outbreaks of disease, but they do emphasize again the seriousness of the threat to sustained timber production from heart rots, dwarfmistletoe, and white pine blister rust, the three major disease pests of California forests. Blister rust

Plots must be carefully laid out to obtain accurate information on disease losses under various forest conditions.

on sugar pine was found 20 miles farther south in the Coast Range of Mendocino National Forest. Significant damage to merchantable-size sugar pine was observed in the western portion of Siskiyou County between Dillon and Clear Creeks. New evidence was obtained of dwarfmistletoe damage to Douglas-fir in northern California and to Monterey pine in Monterey County.

The cornerstone of our disease survey program is the body of fact forthcoming from permanent sample plots. These plots are yielding valuable information on: the effect of a given disease upon trees as individuals and as stands, cyclic fluctuations of diseases within a stand, and the rate and nature of spread of diseases. The Station's program calls for setting up a statewide network of plots totaling 1,440 acres by 1967. The plots will sample disease damage by age class and timber type within each of five subregions. Plot, tree, and disease information is recorded in code in the field. This information is later transferred directly to punch-cards to speed analysis of the data.

We now have more than 142 acres in study plots located throughout the State. With information made available from these plots and detection reports, a map showing the known distribution of each important forest disease in California is being compiled.

ENVIRONMENT DETERMINES BLISTER RUST HAZARD

Lower costs and more effective blister rust control methods are being sought more and more through management of sugar pine for maximum growth and control of rust on selected sites. Management units are widely dispersed from north to south in the Sierra Nevada and vary a good deal in local and general climate. To guide control, we are continually seeking a better understanding of environmental factors and their influence on rust behavior. For example, an analysis of 30 years' rainfall records in the sugar pine region shows that the years with fall weather too dry for pine infection increase in number southward in the Sierra Nevada. In Sequoia National Park 18 out of 30 were too dry; at Mt. Shasta only 10 out of 30.

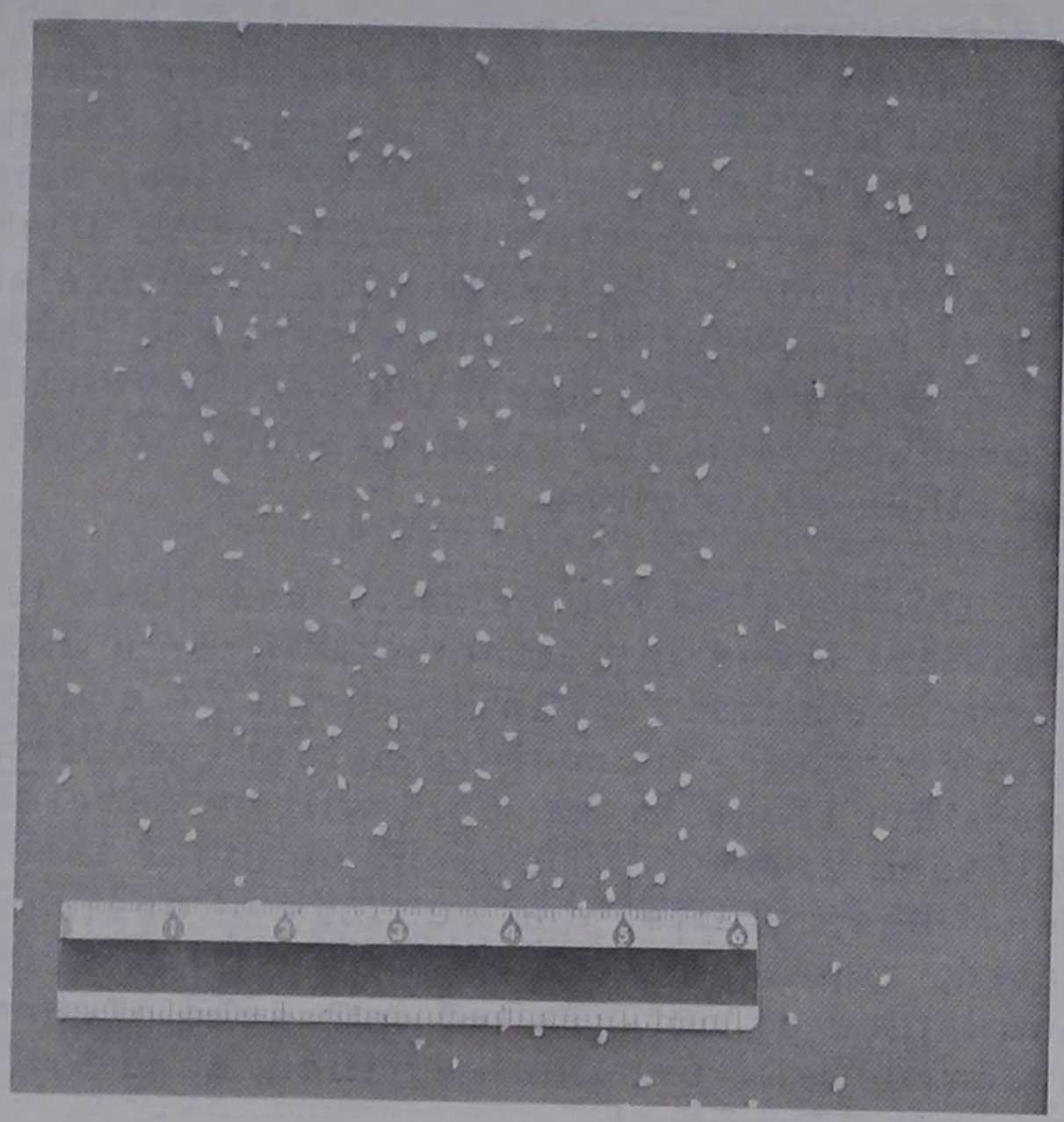
Continued studies in the climate-control mycotron of the Department of Plant Pathology, University of California, have given us much needed information on the way time-temperature variations and other environmental factors affect production of sporidia. These pine-infecting spores germinated under mycotron conditions at 28°C. Earlier work suggested that temperatures higher than 20°C. restricted germination of sporidia. Also, pH had a significant effect on the type, time, and vigor of germination. Longevity of sporidia was increased from a few hours to 10 days by the use of a test surface other than glass. Secondary and tertiary sporidia were shown to be pathogenic to sugar pine needles.

Results of these studies, supplemented by field observations of rust spread and behavior, support a recently announced modification of control policy in the southern part of the Sierra Nevada that should lower control costs.

CHEMICAL CONTROL OF RIBES SIMPLIFIED

Progress in a long-term control job usually creates a need for changes in field procedures and pesticides. For example, most of the large-scale spraying of mature ribes bushes has been completed;

Dry 2,4-D pellets provide a safe and convenient method for killing scattered patches of ribes seedlings and crown-sprouts. The lower photo shows the density pattern of a dosage of about one pound per square rod.



consequently seedlings or sprouts from the root-crown of partially killed plants are requiring more attention in blister rust control operations. Field tests of the past several years show that two new formulations should help forest managers do an effective job of suppressing seedlings and low-growing sprouts.

One is a propionic ester spray of 2, 4, 5-T, which seems to be generally effective on ribes throughout the growing season. In contrast, the regular (acetic) sprays of 2, 4-D and 2, 4, 5-T are effective only at certain parts of the season. The other consists of dry pellets impregnated with a volatile ester of 2, 4-D. They can be broadcast by hand and thus lend themselves to intermittent and spot treatment. About one-half to one pound of the pellets per square rod will kill a high percentage of seedlings and short sprouts of Sierra Nevada gooseberry. Increased dosage may make them effective near the end of the growing season when small associated conifers are least likely to be damaged.

SOME SUGAR PINES ESCAPE ATTACK BY BLISTER RUST

For some years we have known that a very occasional sugar pine among heavily infected companions escapes attack by white pine blister rust. We believe that these rare trees are inherently resistant to the rust and that they are legitimate candidates for testing and propagation as superior trees. Also, some foreign species of white pine are practically immune to blister rust and may be useful in improving resistance of native selections. A committee representing management and research from private, State, and Federal agencies recently outlined the steps needed to produce seed and planting stock of rust-resistant sugar pine and other white pines.

During 1957 top priority was given to the search for rust-resistant trees in northern California and southern Oregon infection centers. By this search we added about 40 sugar pines to our register of rust-resistant candidates. Candidate rust-resistant trees in the field will be carefully described, marked, released from competition by other trees, and fertilized. Seedlings, grafts, and cuttings of desirable trees will be propagated, repeatedly tested for rust resistance, and eventually outplanted or out-grafted into seed orchards. Ultimately these orchards will provide certified seed for rust-resistant sugar pine planting stock.

DWARFMISTLETOES GET MORE ATTENTION

Forest managers and researchers are attacking the dwarfmistletoe problem at three points--better detection, more intensive use of facts already established, and basic research. In cooperative studies at the University of California, two graduate students in Botany and one in Plant Pathology are busy seeking new facts about:

...Susceptibility of different host trees to the several species and forms of dwarfmistletoe.

...Seed dissemination and attachment.

...Germination and growth of dwarfmistletoe within host tissue.

...The impact of this growth on the anatomy and function of conducting tissues of the host.

As rapidly as possible, information from these studies will be applied in field demonstration tests of silvicultural and chemical control.

In the search for chemical control methods, we tested some new chemicals and new methods of applying them. Two were tried in water-mixed sprays: sodium pentachlorophenate, tested for the first time, and Sodar (disodium methylarsonate), applied at an earlier period in the season to round out preliminary tests of 1956. Four--pentachlorophenol, a mixture of 2,4-D and 2,4,5-T low volatile esters, Chloro IPC, and Sodar--were tested as emulsions painted over the canker or applied to fresh incisions in the main stem of the tree. These emulsions are about the consistency of mayonnaise and adhere readily to irregular or vertical surfaces.

As yet none of the chemicals has proved to be a true eradicant, in the sense that it killed both aerial shoots of dwarfmistletoe and the parts growing within the tree. A few chemicals have suppressed dwarfmistletoe the second and third years after application. This suppression was expressed both in the size of aerial shoots and in berry production. Future tests will utilize chemicals showing the most promise in the past as well as new formulations as they become available. Development of new techniques for application will be emphasized.

HOW DOES YOUR HEART ROT GROW?

Heart and butt rots have long been recognized as a major source of loss in merchantable timber. Californians own some 80 billion board-feet of cull decay in standing timber and nothing can be done now to restore this decayed wood. Nevertheless it is important to know how fast wood is being lost to decay fungi and how site and climate affect the rate of decay. Such information will help forest managers schedule their cuttings in present merchantable stands and will help them reduce heart rot losses in the future.

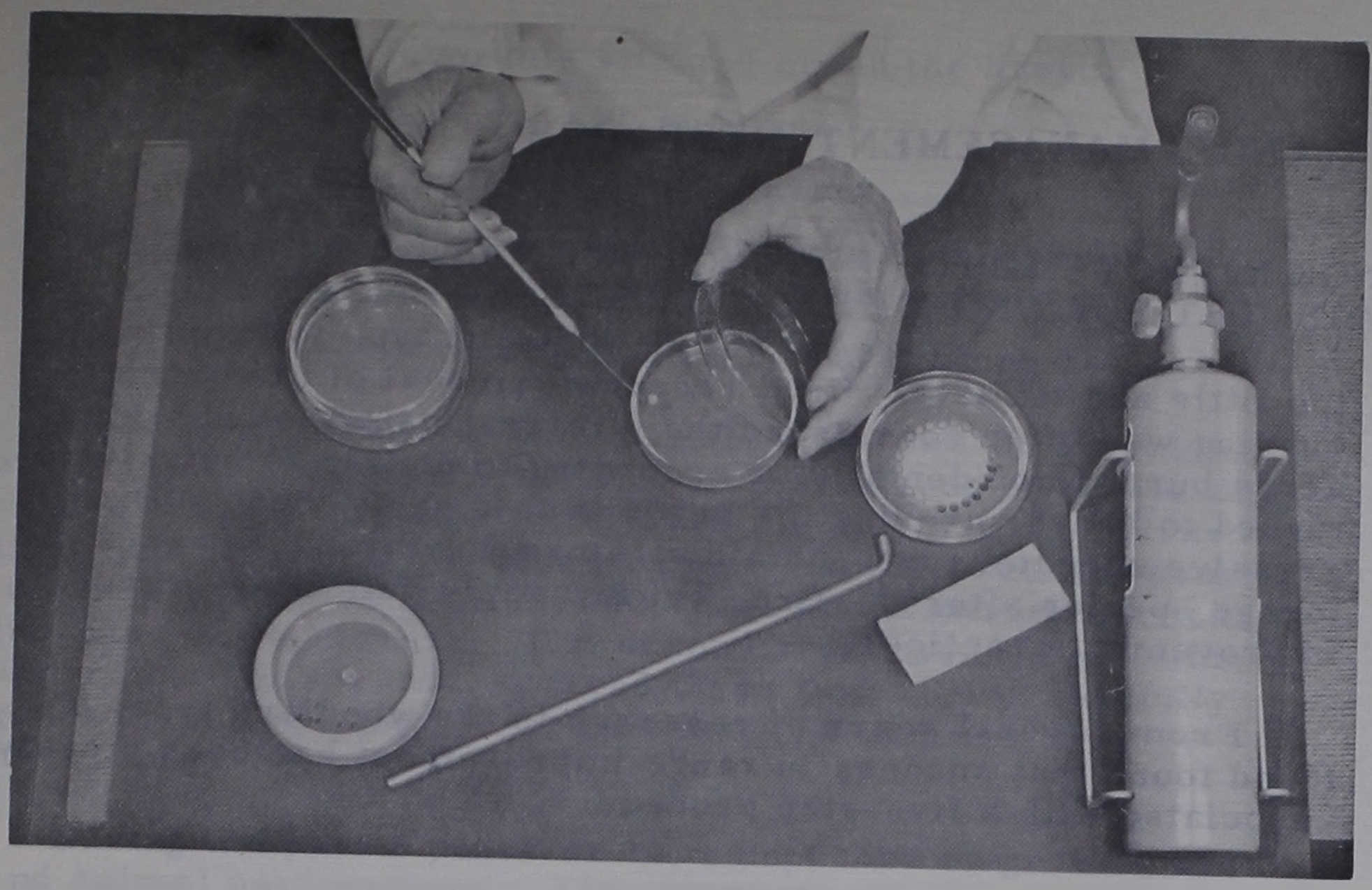
We believe that temperature exerts a major influence on the growth of heart-rotting fungi. As the first step in an attack on basic aspects of this problem we are now measuring growth rates of several strains of the Indian paint fungus. Cultures have been isolated from infected wood and from conks collected from trees of different ages, different locations and altitudes, and various heights in trees.

Isolates from each source are established in Petri dishes on a malt agar medium. After these isolates have grown to a suitable size, small discs are cut from around the perimeter of the culture. One of these discs is then planted in the center of each test plate.

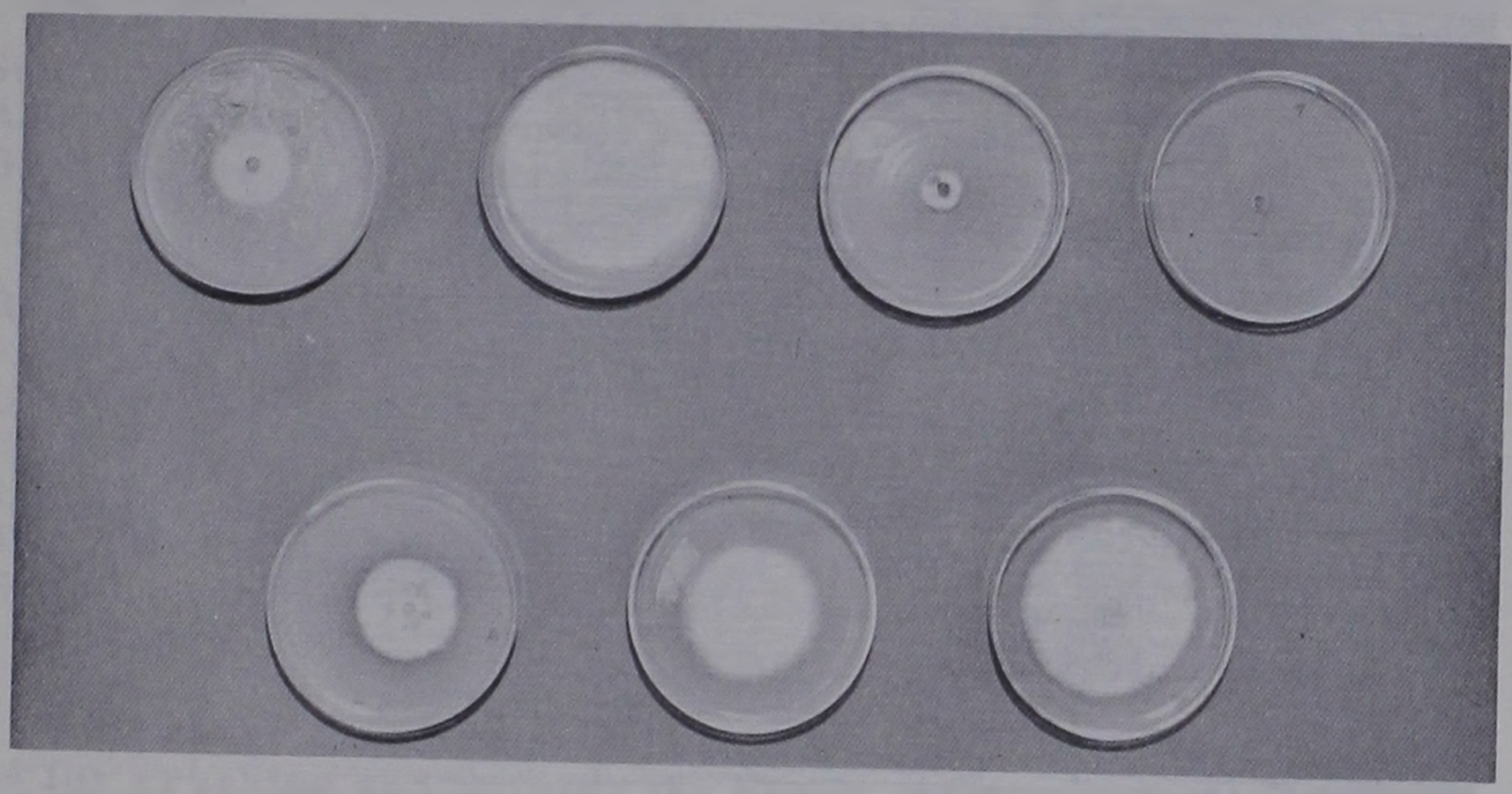
After a short incubation period, the test plates are divided among a series of controlled temperature chambers operating at eight levels ranging from 46°F. to 97°F. During the next month, growth of the fungus is measured daily along two diameters.

The growth records are later subjected to a complete statistical analysis. We expect the analysis to give us information about differences in growth rates between source strains, the optimum temperature for the growth of each strain, and whether there are any consistent relationships between these two factors and climate. Major differences in strain growth at constant temperature have already been observed, and the effect of different temperatures on a single strain is even more pronounced.

If the growth rate of the fungus in wood is found to be proportional to its growth on malt agar, we may be able to recommend pathological cutting cycles based upon local temperature regimes. Such a cutting cycle will enable the forest operator to delay his cut for maximum growth increment without danger of excessive losses from heart rot. At the same time, the source of infective material will gradually be reduced, resulting in healthier timber stands.



Small discs are cut from several "seed" or mother cultures prepared from specimens of white fir infected with the Indian paint fungus. The discs are used to start replicated cultures grown at predetermined temperatures.



The top row of four cultures shows growth response during 1 month at (left to right) low, optimum, high, and very high temperatures. Three cultures in bottom row are different strains of the fungus grown at the same temperature.

RANGE MANAGEMENT RESEARCH

RANGE IMPROVEMENT BEATS JUST BURNING

Range improvement effort in California's foothill woodland type is generally too little and too late. Until recently removal of the brush by burning was often considered the full treatment needed. Many acres burned accidentally or according to plan have quickly returned to brush, proving the error in this early view. Progressive operators and administrators now broadcast seed of forage species after the fire, but few apply full scale range improvement practices.

From several years of research in the woodland type, we found found that success in range improvement has been closely associated with a five-step procedure.

Woodland range improved by burning the brush, seeding forage species, and spraying in three successive years. Untreated check strip runs through improved area.

1. Select a favorable site and crush the brush.
2. Remove the brush by burning.
3. Seed forage species in the ashes.
4. Spray the area with 2,4-D annually for three years to control brush seedlings and sprouts.
5. Regulate intensity and season of grazing use.

What this procedure can do is shown by two areas studied since 1950. Originally they had similar stands of brush, one with 3,300 and the other with 2,500 plants per acre. The first was burned in the usual manner and allowed to revert to brush. By 1957 it had 3,800 brush plants per acre, an increase of 15 percent. The second area was burned at the same time but seeded, sprayed three times, and carefully grazed. It had only 100 brush plants per acre in 1957--a reduction of 99.6 percent.

During the past 2 years we have kept tabs on grazing use and animal performance. The comparison: .

	Fully improved range	Unimproved or burned only
Returns in 1956:		
Length of grazing season, days	135	135
Stocking, acres per animal	4.4	7.5
Animal weight gain, pounds	135	105
Grazing use, animal-days per acre	30.4	18
Returns in 1957:		
Length of grazing season, days	153	104
Stocking, acres per animal	4.8	7.5
Animal weight gain, pounds	202	130
Grazing use, animal days per acre	32.0	14

Full range improvement in these tests cost $25 per acre: $4 for crushing and burning the brush, $21 for seeding and spraying. For this cash outlay full improvement has given a 20 percent longer grazing season, 63 percent heavier stocking, 43 percent more gain per grazing animal, and a 95 percent increase in grazing use.

1

Conversion of selected brushland areas to grassland can produce

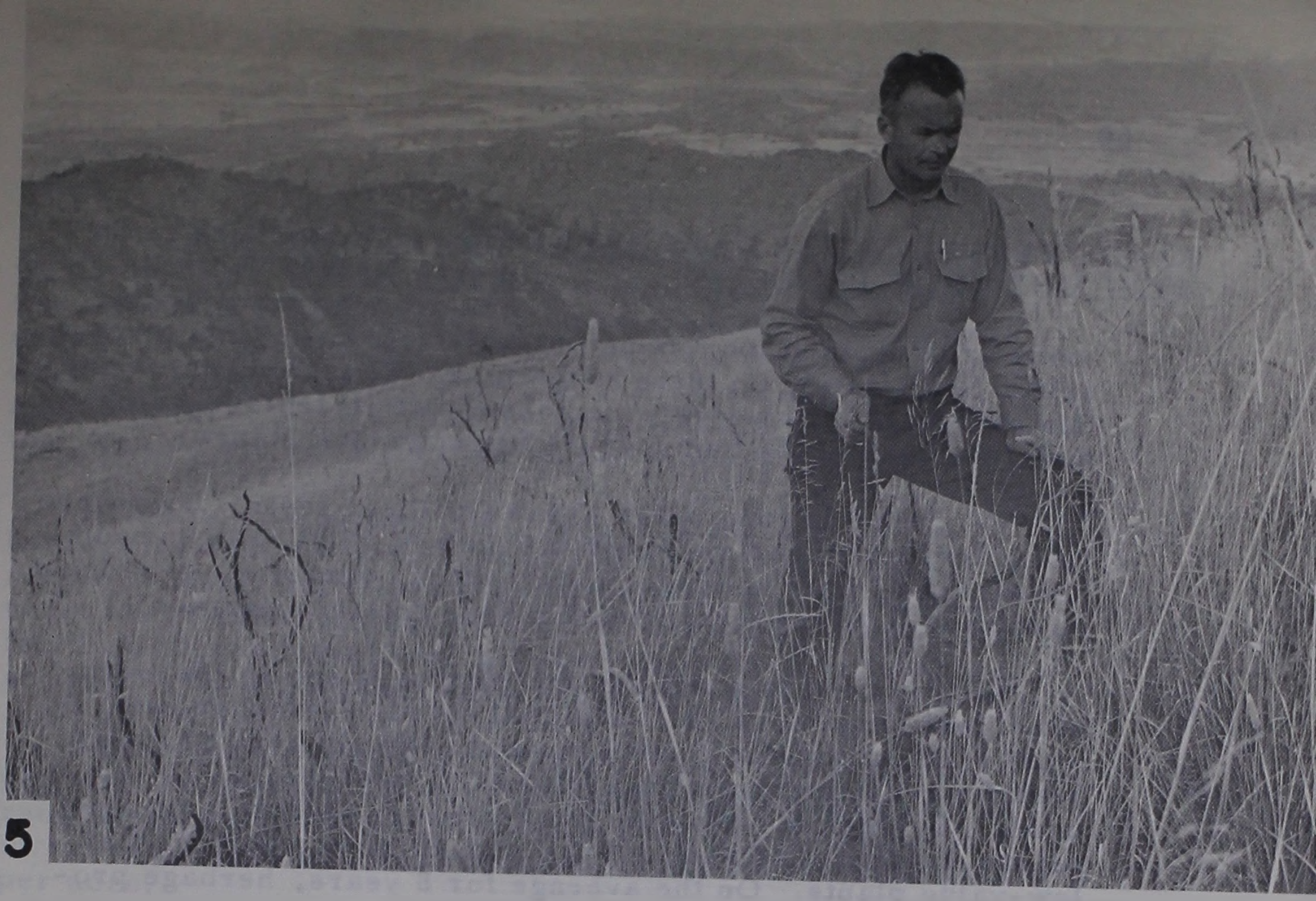
...more grazing
for livestock
...better habitat
for game
...more breaks
for fire fighters

A pilot study on the Mendocino National Forest shows what it takes to turn the trick.

2

3

4



5

CHAMISE.....

.....TO GRASS

1. SELECT suitable areas...on ridges and benches, with moderate gradient and good soil...and...

   PREPARE the brush for burning...by smashing it with a bulldozer and clearing fire-control lines.

2. REMOVE the brush by safe burning...use area ignition; then the compacted brush burns readily when standing brush isn't likely to.

3. SOW adapted forage species in the clean seedbed...use a heavy-duty drill and a seed mixture that includes recommended perennial grasses.

4. SPRAY to kill brush seedlings and sprouts...with a selective, hormone-type chemical that does not injure the grass.

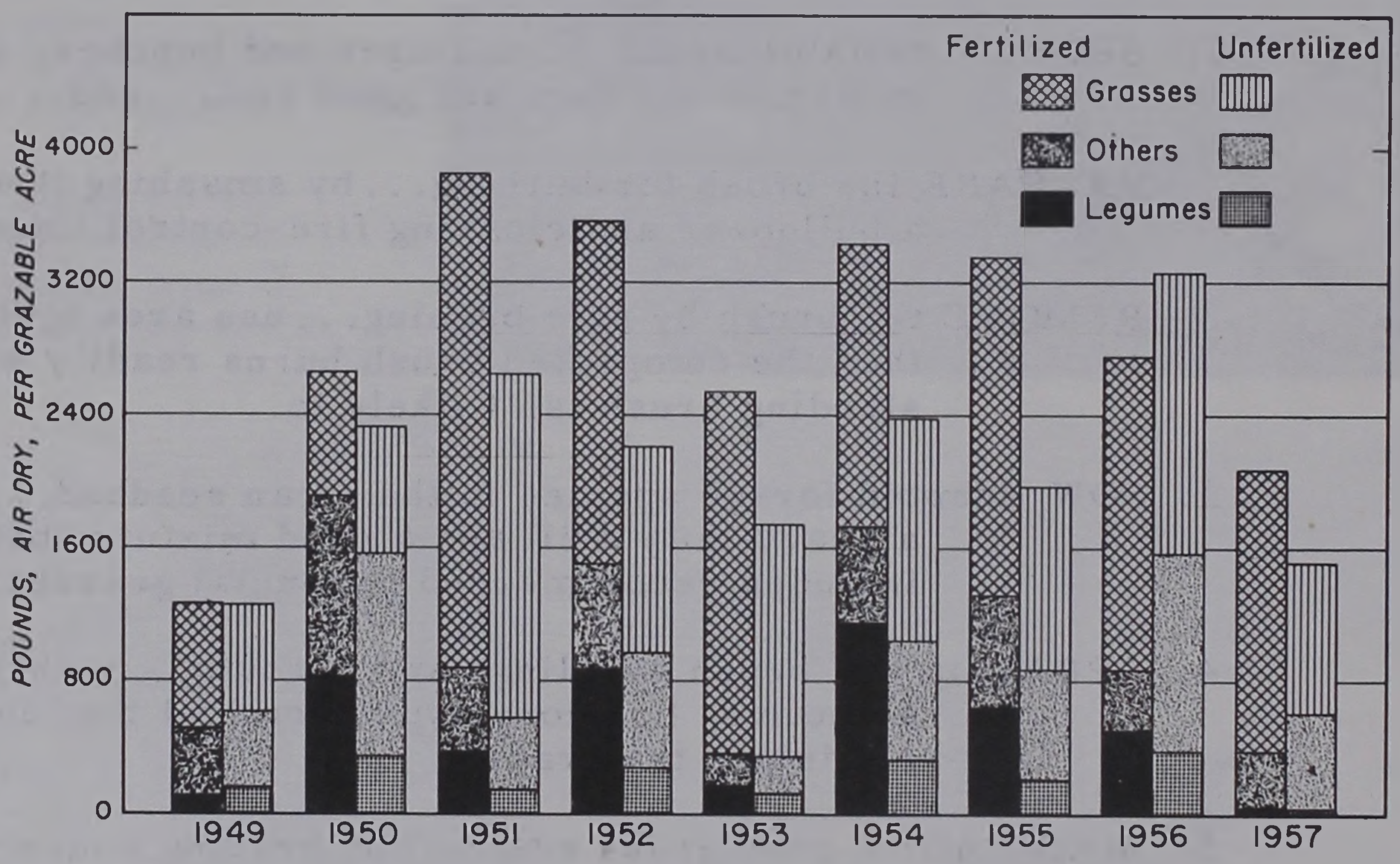
5. MAINTAIN a good grass stand...by grazing conservatively to promote vigorous growth and assure a good soil cover.

RANGE FERTILIZATION PAYS OFF WITH MULTIPLE BENEFITS

Livestock ranchers in the Sierra Nevada foothills can produce more grass, more grazing, and more meat at relatively little cost through sulfur fertilization on their range land. These multiple benefits have been conclusively demonstrated in tests running several years at the San Joaquin Experimental Range.

We set aside four range areas for these tests. Two were left unfertilized; two received 360 pounds of pit-run gypsum, containing 60 pounds of elemental sulfur, per acre--broadcast on the range every third winter before the rainy season.

Range workers could see the effects starting the year after fertilization: first, stimulation of legume growth, mostly native legumes; then increased production of grass herbage resulting from the build-up of soil nitrogen by legumes. Besides boosting the production of desirable forage plants, fertilization reduced the amount of weeds and other low-value plants. On the average for 8 years, herbage production was increased 57 percent.



Fertilization increased estimated range grazing capacity 56 percent. Actual stocking in most years was below the estimated grazing capacity because suitable cattle were not available for the study. Nevertheless, stocking averaged 32 percent heavier during the dry-herbage season, and 37 percent heavier during the green-herbage season than would have been possible on the same range unfertilized.

Livestock gains improved too. During the green-herbage season, the only one held entirely free of supplemental feeding, fertilized acres produced two and one-half times more yearling gain than did unfertilized acres. The fertilized acres were most productive every year--barely so in 1951 but seven and a half times over in 1957.

This kind of range fertilization costs $1.50 per acre per year--a small price for 700 extra pounds of grazable range herbage and 35 percent more grazing per year plus an increase of two and a half times in pounds of livestock gain per acre.

FOURWING SALTBUSH GOOD PROSPECT FOR GAME RANGE SEEDING

Compared to bitterbrush the most widely used browse species in western game range seeding, fourwing saltbush has some outstanding attributes:

	Fourwing saltbush	Bitterbush
No. of clean seed per pound	44,000 to 55,000	16,500 to 23,000
Seed dormancy	Low--variable	Very high
Germination after dormancy		
Laboratory	30 to 58 percent	50 to 95 percent
Field	10 to 35 percent	30 to 50 percent
Height growth, same site		
End first year	20 to 34 inches	4 to 7 inches
End second year	32 to 48 inches	12 to 24 inches
First flowering	2nd growing season	4th growing season

The superiority of saltbush in rate of growth and age at first flowering favors wide use of the species in future plantings. The low germination is more than offset by the greater number of seed per pound and by the absence of high seed dormancy, which requires stratification or other treatment. These features are a part of the solution to the problem of what, where, when, and how to rehabilitate browse winter ranges in California's eastside region.

LARGE SCALE BITTERBRUSH SEEDING SUCCESSFUL

Application of bitterbrush seeding know-how developed through research was successfully demonstrated on 18 acres of deteriorated range land last spring. The job was costly--$45 per acre--because the site was severe and every precaution was taken to avoid failure. Mechanical removal of brush and trees from the site, preparation of the soil for planting, and seed procurement each made up 25 percent of the cost. The remaining 25 percent was spent on insecticide and its application, drilling, and miscellaneous items. Machinery especially adapted to rough range sites was used throughout.

The resulting seedling stand exceeded 15,000 plants per acre: more than three times the number considered adequate for a satisfactory stand. A 15 percent loss during the summer--caused by trampling by livestock, rabbit activity, drought, and other factors--reduced the stand to 12,600 seedlings per acre 5 months after planting. This is an average of one plant to about 3-1/2 square feet of surface or a spacing of 1.9 feet between plants. Average height attained by the end of the growing season was 2.2 inches.

Current efforts are being concentrated on reduction of costs through reduced seeding rates, use of fire in land clearing, and other improved practices.

NEW RESEARCH STARTED ON BIG-GAME HABITAT

The ever-increasing pressure of California's burgeoning population for recreational hunting has made efficient management of game ranges a top priority job. This year we started an analysis of habitat conditions on big game ranges in northeastern California. This problem analysis marks the beginning of research designed to develop information which will provide a sound basis for improved game habitat management systems.

What are some of the problems involved? Start with the soil--the basis of all resource value. In California more than 260,000 acres of wildland are burned over annually. How can we quickly restore or replace the burned vegetation on different kinds of soil--and more important, how can we hold the soil while restoration is taking place? What are the hardiest, most nutritious, and most easily established plants that can be grown on these deteriorated ranges? What is grazing capacity, proper stocking, and a desirable balance between big game and livestock?

Or consider the established plants. In places, vast stands of bitterbrush have died; they once provided essential browse on important deer winter ranges. Did the plants die because of too heavy grazing, disease, insects, drought, competition, or other factors? No one knows.

This analysis and the research which grows out of it will determine the most likely cause or causes and develop means of meeting the situation. Maintenance of California's deer population at its present high level depends upon the development of answers to such problems. The future of recreational hunting is firmly tied to the deer herd.

Mapping extensive areas of bitterbrush is first step in a search for ways to improve game habitat.

SEASON AND CLASS OF GRAZING AFFECT CONDITION OF BITTERBRUSH

Some clues as to why game habitat conditions vary came from an ecological study of two browse ranges on the Inyo National Forest. Separated arbitrarily by the 7,000-foot contour of elevation, they are used in summer by different kinds of livestock and at different seasons by deer. Bitterbrush, the primary forage species on both units, differs markedly in condition.

The higher unit, lying between 7,000 and 8,400 feet in elevation on the east slope of the Sierra, is grazed in late summer by sheep and by deer during their spring and fall migrations. It has a vegetative cover of about 38 percent, a strong third in bitterbrush. Sagebrush composes more than half the vegetation and the rest is herbaceous plants and minor shrubs. The bitterbrush is thrifty, 37 percent of the plants are under 20 years of age, and natural seedlings have become established on this range in 4 of the past 5 years. Nearly 600 clusters, on the average, totalling 1,860 seedlings per acre were found. This evidence of satisfactory regeneration and the fairly young age of the stand indicate that neither degree, pattern, nor season of use is detrimental to the preferred bitterbrush on this range.

Downhill, between 5,300 and 7,000 feet, the range is grazed somewhat by cattle in summer and very heavily by deer in winter. Deer concentrate on this range in winter because of snow and inclement weather at higher elevations and agricultural and other activity in the valleys lower down. Vegetative cover is only 21 percent on this winter range. A quarter is bitterbrush, half is sagebrush, a fifth minor shrubs, and the rest herbaceous plants. Only 11 percent of the bitterbrush plants are under 20 years old. The first seedlings to become established in the past 5 years, 28 clusters with a total of only 49 plants, appeared in 1957. These may soon disappear with heavy deer use.

Obviously, the sparse stand of decadent plants on the winter range is in unsatisfactory condition and will very likely decline further under continued winter use. The high spring-fall range is in satisfactory condition, at least as to bitterbrush, and probably will improve under continued similar treatment. These conclusions are held valid regardless of recognized minor differences in rainfall, temperature, and site quality.

WATERSHED MANAGEMENT RESEARCH

RESEARCH ORIENTED TOWARD MORE GOOD WATER

Through the financial cooperation of California's Department of Water Resources and the California Division of Forestry, and the field cooperation of others, we have been able to expand and orient watershed management research toward the production of more good water.

Fifteen studies are underway in the high Sierra snow zone, and a major pilot test applying results of basic research to entire watersheds is underway in southern California. A cooperative study of watershed and fish habitat management with the University of California Department of Zoology was started on the Sierra east side. The Weather Bureau is taking special wind records at Blue Canyon, and Pacific Gas and Electric Company is helping us measure wind, snowfall, and streamflow in the upper Kings River.

CALIFORNIA'S SNOW ZONE HAS MORE BRUSH THAN TREES

The principal snow storage zone of California, the area above 5,000 feet in the Sierra Nevada, has more brush than trees.

This rather surprising information is the result of an aerial photo survey from which we determined forest densities, sizes of forest openings, and other land types in the Sierra. Two strips across the Sierra were studied--one 70 miles wide and the other 35 miles. Brush covered 33 percent, tree-crown covered only 23 percent.

The most common slope was one of about 15 percent facing southwest; however, more than one-fourth of the slopes are steeper than 30 percent. One-fifth of the slopes face north and another one-fifth face east.

Purpose of the aerial photo inventory is to assure that no important land conditions are overlooked in designing studies aimed at increasing California's water yield. We know now, for example, that the dominance of brush necessitates study of its management in addition to timber management. The inventory will be useful, too, in applying the results of studies, by pointing out where and how much area may be subject to management techniques now being developed.

Brush cover exceeds tree cover in much of the high Sierra.

WIND GOVERNS MUCH OF SNOW ACCUMULATION

What kind of winds do we have in the Sierra? The answer will play a big role in snow-forest management, because wind movement during and after snowfall controls snow accumulation and drift.

At the Central Sierra Snow Laboratory near Donner Pass, south and southwest winds accompanied 88 percent of the snow that fell during the first three months of 1957. Average wind speed during precipitation was 6.4 miles per hour--almost twice the speed (3.6 m.p.h.) when no precipitation fell. Similar relations had been found for the same location in the 1947-48 winter, except that predominant wind during precipitation was southerly; in 1957 it was southwesterly. Big and small storms had similar wind speeds. We are now measuring winds, snow accumulation, and drift in forest openings of different size and exposure.

FOREST SLOPE AND HEAT AFFECT SNOW MANAGEMENT

There are hot slopes and cold slopes in the Sierra; ask any skier. We will need to take this difference into account when designing snow management practices to increase and delay water yield. Studies at the Snow Laboratory have shown that snow accumulation and melt were more closely related to the heat received by a slope than to any other factor studied. In winter, south slopes received three times the direct solar radiation that cooler north slopes received; consequently, south slopes had 22 inches less water at the time of maximum winter snowpack. In spring, melt was nearly twice as rapid on these hot south slopes.

We find that forests play a two-sided role in snow accumulation and melt:

> ...Trees intercept part of the snowfall. Some of this snow is evaporated and lost to the atmosphere. Some may melt and pass directly through the snow pack and into the soil. Some may be blown or slide from the trees and form drifts.
>
> ...Trees also intercept solar radiation and wind. This prevents heat from reaching the snowpack.

The net result was that under trees the winter snow water accumulation was as much as 9 inches less than in large open areas. Then in the spring, snow melt in well stocked stands was reduced by the shade cast by trees. In very sparse forests, however, snow melted faster than in the open or in denser forests. To get a better picture of the role of forests in snow accumulation and melt, these studies are being extended by measurements of snow and heat at 58 snow courses in many combinations of forest openings and densities with various slopes and exposures.

HIGH SIERRA WATERSHEDS GAGED

We are measuring the pulse of water flow and sedimentation on 11 snow-zone watersheds in the headwaters of the Kings, American, Yuba, and Truckee Rivers. The catchment areas range in size from 120 acres to 12 square miles and represent many combinations of forest, brushlands, and meadows, as well as alpine and sub-alpine locations.

When these watersheds are calibrated, timber harvesting, planting, brush conversion, and other management practices will be applied. Application will be guided by basic research studies now underway. Our objective is to find out how much more water can be obtained, how delivery of water can be prolonged, and at what expense, if any, in sedimentation.

NEW PILOT WATERSHED STUDY SEEKING MORE WATER FOR SOUTHERN CALIFORNIA

In spite of all the water imported to southern California, 70 percent of the water used in the south coastal basin comes from local watersheds. Can more good water be obtained through intensive watershed management? Two watersheds on the San Dimas Experimental Forest in southern California are being placed under intensive management to find out.

Basic studies at San Dimas and elsewhere show that trees along the stream channels are heavy users of water, and that a grass cover on deep soils uses less water than chaparral. Now, these results are being tested on whole watersheds.

Monroe Canyon, an 875-acre watershed whose performance has been calibrated for many years, has about 100 acres of oaks, alders, willows, and other trees and shrubs along the channels. This vegetation keeps the stream bottom dry much of the year and will be poisoned and removed. The adjoining Volfe Canyon will be maintained as an untreated control watershed to permit quantitative evaluation of the treatment. Both canyons are typical of the San Gabriel Mountains--very steep, highly fractured, and heavily brush covered except for the woodland-riparian zone along the channels.

A significant increase in water yield from Monroe is anticipated. Some flood peak discharges, on the other hand, are expected to be reduced. Removal of the trees in the channels will prevent temporary plugging and subsequent surges of flow which are the cause of some of the highest and most damaging streamflow peaks in southern California's mountain watersheds.

Stream channel vegetation in Monroe Canyon, a typical southern California watershed, is being managed to increase water yields.

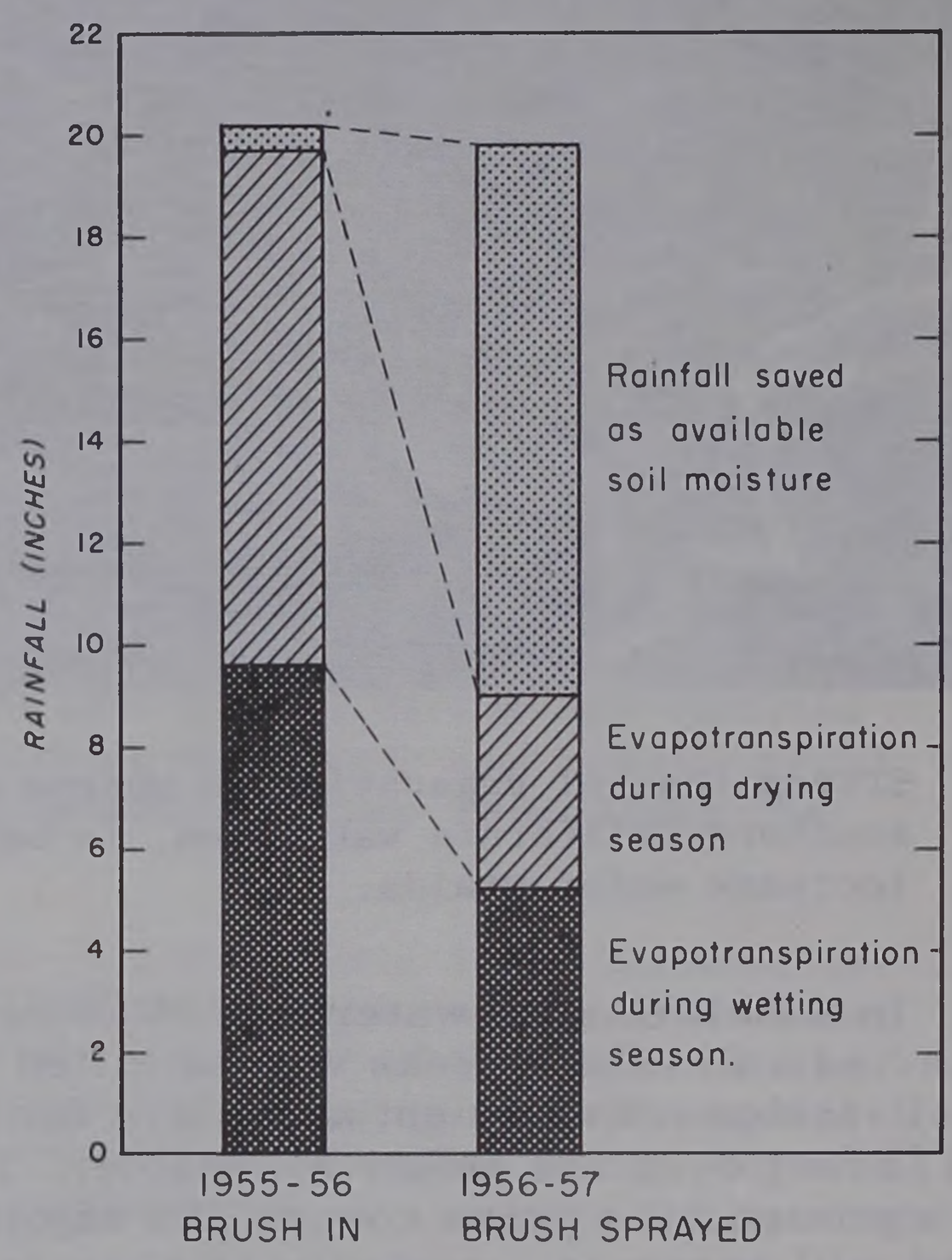
In a Bell Canyon watershed of 65 acres, the chaparral on selected side-slope areas will be killed by aircraft application of silvicides. Treatment areas are limited to soils at least 2-1/2 feet deep and relatively stable. Treated areas will be revegetated by a grass cover. An adjoining calibrated watershed will serve as a control and provide a basis for evaluating results through soil moisture and streamflow behavior studies.

BRUSH DEFOLIATION MAY SAVE WATER

Nearly half of the rainfall in southern California's mountains is lost through evaporation and transpiration. Will temporary defoliation of chaparral save water?

Disposition of rainfall in dense scrub oak and other native brush has been studied at San Dimas Experimental Forest for many years. During the fall of 1956 and early in 1957 one set of brush plots was sprayed with a heavy concentration of 2, 4, 5-T. Soil moisture from near the surface down to bedrock was measured weekly before and after the brush was sprayed. The soil averages about 12 feet deep. Water losses through evaporation and transpiration after the brush was sprayed were less than half the loss from full-foliaged brush areas.

Full-foliaged brush plots lost 19.7 inches of water; sprayed plots, only 9.0 inches. The carryover of 11 inches of soil moisture in the sprayed plots will result in percolation below the root zone and increased streamflow during succeeding years if the area is maintained free of deep-rooted shrubs and forbs, and rainfall is sufficient to fully wet the soil.



What time of year will defoliation be most productive? The effect of time of defoliation was studied in small portable lysimeters (tanks) each containing a single plant of laurel sumac growing in soil 2 feet deep. Monthly, starting in May, two plants were defoliated with sulfur dioxide gas. Evapotranspiration was determined

Research forester at San Dimas Experimental Forest--
Will defoliation increase water yield?

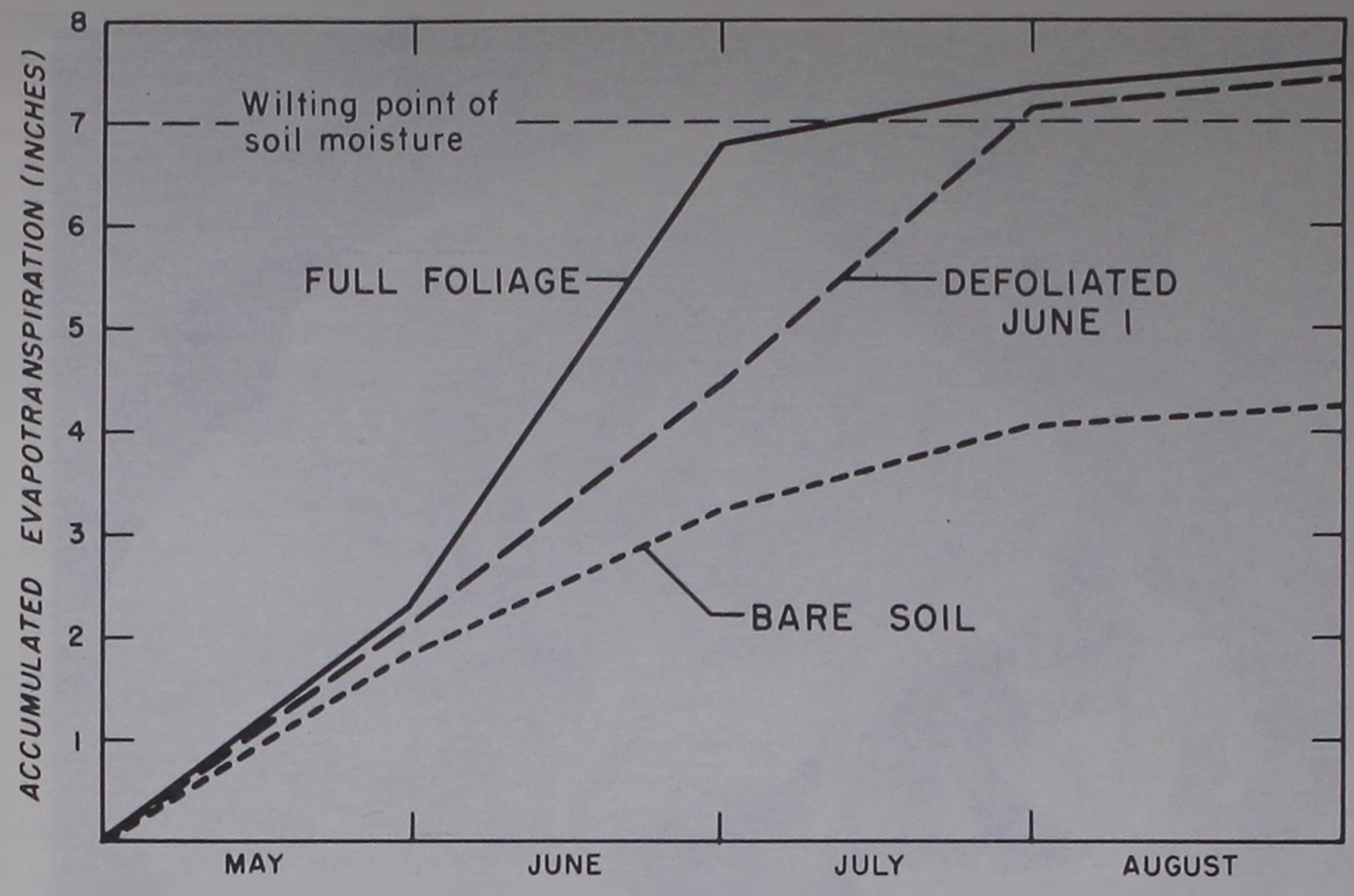
by measuring rainfall and changes in the weights of the lysimeters. Evaporation from bare soil in similar tanks was obtained for comparison.

This study using 2-foot tanks showed that:

... June defoliation maintained soil moisture at a higher level for a longer time. Defoliation decreased plant water consumption by as much as 0.11 inch per day during the period of high moisture availability.

... Plants defoliated on May 1 and June 1 survived the summer drought with a few new green leaves, but plants defoliated July 1 and August 1 and untreated plants appear to be dead.

... Defoliation changed the rate of evapotranspiration use, but in these shallow tanks had little effect upon total seasonal use.



Sulfur dioxide was found to be a cheap, easily applied, and universally effective defoliant for chaparral species. Concentrations of 1 cubic centimeter of liquid sulfur dioxide per 15 cubic feet of air (about 1,000 parts per million) gave a complete leaf kill when applied to shrubs under a plastic cover. There was no apparent damage to buds or twigs.

The effect of defoliation upon moisture use in deep soils will be tested next.

PUBLICATIONS

Adams, Lowell
A way to analyze herbivore food habits by fecal examination. 22d No. Amer. Wildlife Conf. Trans. 1957:152-159, illus.

Describes technic with which biologists can measure food consumption by herbivores in the field.

Anderson, Henry W., and Church, J. E.
Forest-cover effects on snowpack accumulation and melt, Central Sierra Snow Laboratory. Amer. Geophys. Union Trans. 38(1):116. (Discussions)

Discusses the status of Church's "honeycomb" forest and Anderson's "wall-and-step" forest as guides to logging for snowpack management.

Anderson, Henry W.
"Operation Wet-Blanket" gets underway. Amer. Geophys. Union Trans. 38(3):414. (Abstract)

Outlines the snowpack management studies now being conducted in cooperation with the California Department of Water Resources.

Anderson, Henry W.
Relating sediment yield to watershed variables. Amer. Geophys. Union Trans. 38(6):921-924.

Discusses uses of multiple regression analysis as a means of relating sediment yield to such variables as watershed conditions and the nature of storms and streamflow.

Anderson, Henry W., and Pagenhart, T. H.
Snow on forested slopes. Western Snow Conf. Proc. 1957:19-23.

Snow accumulation and melt at 31 Central Sierra Snow Laboratory snow courses are related to terrain, solar energy, and forest variables.

Andrews, Lowell A.
Inexpensive maximum water stage recorder. Engin. News. Record. June 13, 1957:86, illus.

Describes an easily built instrument that can be used to record peak flow where expensive gaging stations are not justified.

Bega, Robert V.
The use of detached ribes and pine leaves in studies with Cronartium ribicola. Phytopath. 47:9.

Reports on the technique and results of using detached ribes leaves and pine shoots in inoculation studies with the fungus causing white pine blister rust.

Bentley, J. R., and Buttery, R. F.
Bumper forage crops--it takes more than just high rainfall. Western Livestock Jour. 35:152-154.

Average or better herbage production on foothill ranges requires a minimum of 15 to 17 inches of rain well distributed from October to April.

Casamajor, Paul, and Wilson, C. C.
Portable chippers answer to reducing slash fire hazard. The Timberman, June 28, 1957. pp. 50-52.

Highlights studies of the portable wood chipper's potentiality for reducing fire hazard and reviews other benefits which accrue from use of the chipper.

Chandler, C. C.
"Light burning" in southern California fuels. Calif. Forest and Range Expt. Sta. Res. Note 119. 2 pp.

Fuel studies made during Operation Firestop in 1954 show that light burns accomplished little in the way of hazard reduction. These limited tests also show that more studies of brush as a fuel should be undertaken.

Countryman, C. M.
California fire-weather severity in 1956. Calif. Forest and Range Expt. Sta. Res. Note 118. 7 pp., illus.

A survey of the fire-weather severity in northern California shows that the 1956 weather was "easy" as compared to a 5-year average. But in southern California the fire-weather index climbed rapidly to a high level, indicating a heavy fire load.

Countryman, C. M., and Cornelius, D. R.
Some effects of fire on a perennial range type. Jour. Range Mangt. 10(1):39-41.

Six years after a wildfire, cover density of the burned area was far less than that of an adjacent unburned area. Perennial grasses and bitterbrush were decidedly reduced on the burned plots, largely because of change in micro-climate and closer grazing.

Court, Arnold
Wind direction during snowfall at Central Sierra Snow Laboratory. Western Snow Conf. Proc. 1957:39-43.

Wind directions and velocities during and after snowfall were contrasted. South and southwest winds brought 88 percent of storm precipitation, with storm means varying from 2 to 14 miles per hour. Interstorm winds were lighter and less dominantly from the south.

Eaton, C. B., and Struble, G. R.
The Douglas-fir tussock moth (Lepidoptera:Liparidae) in California. Pan-Pacific Ent. 33(3):105-108.

The Douglas-fir tussock moth, which heretofore has been erroneously identified as Oslar's tussock moth, is potentially a serious pest in California fir forests.

Ely, J. B., Jensen, A. W., Chatten, L. R., and Jori, H. W.
Air tankers--a new tool for forest fire fighting. Fire Control Notes 18. (3):103-109.

The Stearman air tanker was fire-tested in 1956 and has won its place in California fire organizations. Use guidelines are urgently needed.

Eriksen, L. N.
Raw materials for particle board industry. No. Calif. Sec. Forest Prod. Res. Soc. Proc. 1957.

Reviews types of raw material suitable for particle board manufacture and summarizes volumes and types of manufacturing wood residues available in northern California.

Fisher, J. R., and Bradshaw, K. E.
Uses of soil-vegetation survey information in road construction. Soil Sci. Soc. Amer. Proc. 21(1):115-117.

Engineers constructing roads in upland areas derive much basic information from soil-vegetation survey maps and tables. Soil series are characterized as to their behavior for road construction to help the engineer plan the proper location and design of roads.

Gardner, R. A., and Wieslander, A. E.
The soil-vegetation survey in California. Soil Sci. Soc. Amer. Proc. 21(1):103-105.

Describes the procedures used in soil and vegatation mapping and the kinds of information obtained in the survey. Relates some of the survey problems encountered.

Gleason, Clark H.
Reconnaissance methods of measuring erosion. Jour. Soil and Water Conserv. 12(3):105-107.

Describes four kinds of reference marks that can be easily established and used to measure soil erosion.

Green, L. R., and Bentley, J. R.
Seeding and grazing trials of stipa on foothill ranges. Calif. Forest and Range Expt. Sta. Res. Note 128. 9 pp., illus.

Reports stand establishment from seeding of purple and nodding stipa and their maintenance under grazing and fertilization. Nodding stipa had higher survival, better vigor, and faster recovery after grazing.

Green, L. R., and Graham, C. A.
Observations on growth and control of tarweed. Calif. Forest and Range Expt. Sta. Res. Note 130. 8 pp., illus.

Describes the growth habits and methods for reducing tarweed on annual-type foothill ranges. Mowing in August and broadcast spraying a 50-50 mixture of low-volatile ester of 2, 4-D and 2, 4, 5-T gave effective control.

Green, L. R., and Cornelius, D. R.
Pampasgrass in the Sierra foothills. Calif. Forest and Range Expt. Sta. Res. Note 132. 7 pp., illus.

Reports on propagation, survival, vigor, and grazing value for this grass as determined during a 7-year period at the San Joaquin Experimental Range. Pampasgrass, a perennial, remained green in summer and fall when most range plants were dry on this annual-type foothill range.

Hall, R. C.
Pine reproduction weevil. U. S. Dept. Agr. Forest Pest Leaflet 15. 4 pp., illus.

A report on the life history and habits of the pine reproduction weevil; includes recommendations for control.

Hallin, William E.
Silvical characteristics of California red fir and Shasta red fir. Calif. Forest and Range Expt. Sta. Tech. Paper 16, 18 pp., illus.

Summarizes the silvical information on California red fir and Shasta red fir. The two are believed to be almost identical in their silvical characteristics. The only known morphological differences are those in the cone structure by which the typical species and variety are distinguished.

Hallin, William E.
Silvical characteristics of Jeffrey pine. Calif. Forest and Range Expt. Sta. Tech. Paper 17, 11 pp., illus.

Summarizes the silvical information on Jeffrey pine. The report includes a description of the species, its habitat conditions, growth habits, hybrids, and distribution.

Hellmers, Henry
Chaparral plants. (Chapter 14 in Environmental control of plant growth, by F. W. Went.) Chronica Botanica, 341 pp., illus.

Describes two studies conducted in the temperature-controlled greenhouses at the California Institute of Technology: The testing of herbaceous plants for use as "quick cover" on burned areas and the testing of exotic woody plants for use in erosion control in southern California.

Hopkins, Walt
Watershed management considerations for sanitation-salvage logging in southern California. Calif. Forest and Range Expt. Sta. Res. Note 121. 4 pp.

The watershed manager considers sanitation salvage logging beneficial when properly done.

Hubbard, R. L.
The effects of plant competition upon the growth and survival of bitterbrush seedlings. Jour. Range Mangt. 10(3):135-137.

Seedbed preparation, alone and with subsequent weeding, increased seedling growth of bitterbrush and reduced mortality. Three-year-old seedlings averaged 4.5 inches high under native vegetation, but 26.0 inches on a plowed and weeded area.

Johannessen, Carl O.
Anti-freezing hoods for V-notch weirs. Jour. Forestry. 55(8):590.

Describes a simple device to prevent or reduce ice forming on V-notch weirs and outlines results of tests.

Kimmey, James W.
Application of indicator cull factors to white and red fir stands in the Sierra Nevada. Calif. Forest and Range Expt. Sta. Res. Note 127. 7 pp., illus.

Recent checks show that indicator cull factors developed for white fir and red fir in northwestern California apply equally well to these two species in the Sierra Nevada.

Kimmey, James W.
Dwarfmistletoes of California and their control. Calif. Forest and Range Expt. Sta. Tech. Paper 19. 12 pp., illus.

Summarizes essential facts regarding the dwarfmistletoes in California and their control.

Kimmey, James W., and Stevenson, J. A.
A forest disease survey of Alaska. The Plant Disease Reporter, Suppl. 247. Sept. 15, 1957. pp. 87-98.

A brief summary of the general disease conditions found and a listing of fungi collected during the survey.

LeBarron, Russell K.
Silvicultural possibilities of fire in northeastern Washington. Jour. Forestry 55(9):627-630.

Interprets some more or less well-known facts about fires as an ecological factor and shows how such knowledge can be applied in managing forest lands.

May, R. H.
How much forest is there? How much for how long? Coast redwood is important. West. Conserv. Jour. May-June 1957:8-11, illus.

Reviews the available data on Coast Redwood--its area, volume, ownership, rate of growth and rate of cut. Uses these facts, and supplemental economic knowledge, to forecast the future outlook for redwood.

May, R. H.
Production and plant receipts of veneer logs in California, 1956. Calif. Forest and Range Expt. Sta. Forest Survey Release 27. 7 pp., illus.

Reports the highlights of a survey of peeler log receipts at veneer manufacturing plants in California and of logs shipped out of state. Veneer and plywood production is now an important segment of California's forest industry.

May, R. H.
Wood charcoal in California. Calif. Forest and Range Expt. Sta. Forest Survey Release 28. 12 pp., illus.

Reports substantial increase in charcoal production in California in 1956. Also, presents the history of charcoal operations in California and data on cordwood prices, charcoal prices, kiln capacity, and other pertinent facts.

May, R. H.
Wood receipts by fiber and board plants in California, 1956. Calif. Forest and Range Expt. Sta. Forest Survey Release 29. 4 pp., illus.

Reports wood receipts by fiber and board plants in California during 1956. Emphasizes increased use of wood chips as raw material. Report is limited because of possibility of revealing individual plant operations.

May, R. H., and Baker, H. L.
Lumber production in California, 1956. Calif. Forest and Range Expt. Sta. Forest Survey Release 30. 15 pp., illus.

Reports that lumber production reached a new high in California in 1956. Also presents data on lumber production by species, counties and mill-size classes--details not generally provided by the Bureau of the Census.

Miller, H. R., and Wilson, C. C.
A chemical fire retardant--results of field trials using sodium calcium borate on forest fires in 1956. Calif. Forest and Range Expt. Sta. Tech. Paper 15, 20 pp., illus.

Field tests showed sodium calcium borate to be a useful tool and emphasized the need for equipment to simplify and speed up the mixing of chemicals for ground and air tankers. Also, firefighters need more guidelines for using sodium calcium borate.

Miller, R. M.
New techniques in forestry. Machine calculation in the Forest Survey. No. Calif. Sec. Soc. Amer. Foresters. Proc. 1956:35-41.

Describes how the punch card method was used to compile the California Forest Survey area, volume, and growth data. Also describes applications of the method in compiling other types of forestry data.

Moore, A. D.
The relative toxicity of DDT, toxaphene, lindane, and isodrin to Dendroctonus brevicomis Lec. and Ips confusus (Lec.). Jour. Econ. Ent. 50(5):548-550, illus.

A screening procedure was developed and tests conducted with four insecticides--isodrin, lindane, DDT, and toxaphene--to rate their toxicity to the western pine beetle and the California five-spined engraver.

Murphy, James
Helicopter message or cargo drop-and-pickup kit. Fire Control Notes. 18(4): 152-155, illus.

Shows how a drop-and-pickup unit for helicopters can solve communication problems arising when use of radio is limited if crew has been properly instructed in safety practices.

Nelson, Robert E.
Soil-vegetation survey of a central Sierra snow zone watershed. Calif. Forest and Range Expt. Sta. Misc. Paper 21. 43 pp., illus.

Presents a detailed inventory of the soils and vegetation and other land features in the basin.

Nelson, R. E., Bradshaw, K. E., and Wieslander, A. E.
Photo interpretation of vegetation and soils in wild land areas of California. Soil Sci. Soc. Amer. Proc. 21(1):106-108.

Describes how vegetation types can be identified by analysis of features visible on aerial photographs. Also how soil mapping is facilitated by photo interpretation of ground features, land form, and vegetation.

Nord, E. C., and Whitacre, J. E.
Germination of fourwing saltbush seed improved by scarification and grading. Calif. Forest and Range Expt. Sta. Res. Note 125. 5 pp.

Germination success with fourwing saltbush is inversely related to seed size. Moderate scarification hastened the rate of germination and heavy scarification increased total germination.

Offord, Harold R.
Brush control on forest lands. Ninth Annual Weed Conf. Proc. 1957:72-75.

Summarizes the objectives, methods, and problems in controlling brush with chemicals on forest lands, largely national-forest lands, in California.

Pearson, B. O.
Bitterbrush seed dormancy broken with thiourea. Jour. Range Mangt. 10(1):41-42.

Highly dormant bitterbrush seed germinated 85 percent after soaking for 3 to 5 minutes in a 3 percent solution of thiourea. Such treatment opens the way for successful spring planting and avoids the hazards of fall planting.

Rowe, Percy B., and Colman, Edward A.
Uses of soil-vegetation survey information in watershed management. Soil Sci. Soc. Amer. Proc., 21(1):112-114.

Discusses soil-vegetation information required to manage wildlands for flood and erosion control and the need for improved methods for measuring the hydrologic properties of soils.

Roy, D. F.
Seed spot tests with tetramine-treated seed in northern California. Jour. Forestry, 55(6):442-445, illus.

In direct seeding trials in northern California, an acetone-tetramine treatment did not reduce germination of ponderosa pine, but inhibited and retarded germination of Douglas-fir. This treatment protected conifer seeds from rodent depredation. A dextrin-tetramine treatment, however, did not protect conifer seeds and inhibited germination of ponderosa pine.

Roy, D. F.
A record of tanoak acorn and seedling production in northwestern California. Calif. Forest and Range Expt. Sta. Res. Note 124. 6 pp., illus.

Records the number of acorns produced in 1953 by a few tanoak trees near Salyer, California, and the number of one-year-old seedlings produced from this seed crop. Lists several birds and mammals and some insects which feed on tanoak acorns.

Roy, D. F.
Forest tree planting--here's how in the redwood--Douglas-fir region of California. Calif. Forest and Range Expt. Sta. Misc. Paper 20. 31 pp., illus.

Summarizes how to seed or plant conifers on forest land in northwestern California. Tells where, when, what, and how to plant to obtain good results.

Roy, D. F.
Silvical characteristics of tanoak. Calif. Forest and Range Expt. Sta. Tech. Paper 22. 21 pp., illus.

Describes the habitat conditions under which tanoak grows, and the life history and special features of this tree.

Schroeder, M. J., and Countryman, C. M.
Fire-weather survey can aid prescribed burning. Calif. Forest and Range Expt. Sta. Tech. Paper 21. 10 pp., illus.

Reports on a short-term fire-weather survey conducted on Iron Mountain prescribed burn, Lassen National Forest, in 1956.

Schubert, Gilbert H.
Seed-tree selection--a problem in juvenile delinquency? New techniques in forestry. No. Calif. Sec., Soc. Amer. Foresters. Proc. 1956:2-6.

Describes the physical characteristics of ponderosa pine, sugar pine, and white fir seed trees and the location and number of seed trees recommended per acre.

Schubert, Gilbert H.
Silvical characteristics of incense-cedar. Calif. Forest and Range Expt. Sta. Tech. Paper 18. 14 pp., illus.

Summarizes the silvical information on incense-cedar. This report includes a description of the species, its habitat conditions, growth habits, and distribution.

Schubert, Gilbert H.
Silvical characteristics of giant sequoia. Calif. Forest and Range Expt. Sta. Tech. Paper 20. 13 pp., illus.

Summarizes the silvical information on giant sequoia, also known as bigtree and Sierra redwood. The report includes the habitat conditions, the life history, special features, horticultural clons, and distribution.

Schubert, Gilbert H.
California cone-crop--1957. Calif. Forest and Range Expt. Sta. Forest Res. Note 126. 5 pp., illus.

The cone crops of most commercial forest trees in California were generally none or very light. The crop of a few species was medium or heavy in some seed zones, but even in these zones the crop varied greatly.

Smith, Harvey H., and Berolzheimer, Charles P.
Air drying of incense-cedar: tests under summer conditions in California. Calif. Forest and Range Expt. Sta. Res. Note 123. 10 pp., illus.

During the favorable summer weather, 3-inch incense-cedar squares dried faster and with less drying than wider 3-inch thick planks. Pile spacing and position in the pile had no effect on drying rate or incidence of defects.

Smith, R. H.
Habits of attack by the black turpentine beetle on slash and longleaf pines in north Florida. Jour. Econ. Ent. 50(3):241-244, illus.

An analysis of the life history and habits of the black turpentine beetle with particular emphasis on the time and location of attacks. This information is essential for the development of control recommendations.

Smith, R. H.
Death of a pine. Forest Farmer. 15(12):7, illus.

Describes the progressive deterioration of slash pine killed by the black turpentine beetle.

Smith, R. H., and Lee, R. E.
Black turpentine beetle. U. S. Dept. Agr. Forest Pest Leaflet 12. 7 pp., illus.

A description of the life history and habits of the black turpentine beetle; includes control recommendations.

Stanley, R. G.
Krebs cycle enzyme activity of mitochondria from endosperm of sugar pine seed (Pinus lambertiana Dougl.) Plant Physiol. 32(5):409-412.

Cytoplasmic particles isolated from the haploid endosperm contained enzymes similar to those found in the diploid embryo mitochondria; also, their activity was dependent on the water content and age of the tissue.

Stanley, R. G., and Conn, E. E.
Enzyme activity of mitochondria from germinating sugar pine seed (Pinus lambertiana Dougl.). Plant Physiol. 32(5):412-418.

Enzyme studies with radioisotopes showed that the cell particles from pine had activites similar to those of angiosperm plants and animals. A substance which restored the activities of these particles was found in the cytoplasm from ungerminated embryos.

Stanley, R. G.
Glucose metabolism in germinating pine pollen (Pinus ponderosa). Plant Physiol. 32. suppl. XLVI.

Describes changes in the pathway of glucose metabolism and the influence of the Pasteur effect on germinating pollen.

Stevens, R. E.
Fir engraver beetle. U. S. Dept. Agr. Forest Pest Leaflet 13. 7 pp., illus.

A summary of the available information on the life history, habits, and control of the fir engraver.

Stevens, R. E.
Insect-caused damage to the 1956 Douglas-fir cone crop in California. Calif. Forest and Range Expt. Sta. Res. Note 120. 2 pp.

Examination of samples of Douglas-fir cones revealed that insects caused very little damage to the 1956 seed crop.

Stevens, R. E.
Ethylene dibromide emulsion spray for control of the mountain pine beetle in lodgepole pine. Calif. Forest and Range Expt. Sta. Res. Note 122. 3 pp.

A water-emulsion spray of ethylene dibromide has been found effective for control of mountain pine beetle in lodgepole pine. This method is cheaper and less hazardous than the use of oil sprays or burning techniques.

Struble, G. R.
The fir engraver, a serious enemy of western true firs. U. S. Dept. Agr. Prod. Res. Report 11. 18 pp., illus.

A report on the life history and habits of the fir engraver beetle, with additional notes on the character of damage, associated insects, and control measures.

Struble, G. R.
Biology and control of the white-fir sawfly. Forest Science 3(4):306-313.

A report on the life history and habits of the white-fir sawfly with an appraisal of the damage caused, observations on natural control, and recommendations for chemical control.

Wagener, W. W.
The limitations of two leafy mistletoes of the genus Phoradendron by low temperatures. Ecology 38(1):142-145.

Reports the killing of leafy mistletoes in western juniper and white fir by extreme cold. The distribution of these mistletoes is thought to be associated with effects of low temperatures.

Waklee, Floyd W., Shields, H., and Wilson, C. C.
The helicopter--a new member of the hose-lay team. Calif. Forest and Range Expt. Sta. Res. Note 129. 11 pp., illus.

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